Bölüm 4

YENİLENEBİLİR ENERJİ KAYNAKLARI

Chapter 4

RENEWABLE ENERGY RESOURCES

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BÖLÜM İÇERİĞİ

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Profesör İbrahim Dinçer Türkiye Bilimler Akademisi (TÜBA) asli üyesi ve Enerji Çalışma Grubu yürütücüsüdür. Ontario Teknik Üniversitesi tenurlu profesör ve Yıldız Teknik Üniversitesinde öğretim üyesi olan ve sürdürülebilir enerji teknolojileri konusunda öncü Prof. Dinçer'in binin üzerinde hakemli makalesi, yüzlerce konferans makalesi, birçok kitapları ve de kitap bölümleri bulunmaktadır. Yüzlerce uluslararası etkinliğin başkanlığını ve koordinasyonunu yürütmüştür. Aynı zamanda yüzlerce davetli konuşma vermiştir. Birçok uluslararası kurumun aktif üyesi olan, Prof. Dinçer aynı zamanda da birçok dergide baş editör, yardımcı editör ve üye editör olarak görevleri bulunmaktadır. Kanada'nın en büyük araştırma ödüllerinden biri olan "Premier's Research Excellence Award" dahil olmak üzere çeşitli araştırma, eğitim ve hizmet ödüllerinin sahibidir. Geçtiğimiz yedi yıl boyunca Thomson Reuters tarafından "Mühendislikte En Etkili Bilimsel Akıllardan" biri olarak gösterilmektedir ve alanında en çok alıntı yapılan araştırmacılardandır.

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Professor Ibrahim Dincer is a full member of Turkish Academy of Sciences (TUBA) and serves as chair of Energy Working Group at TUBA. Being a tenured professor at Ontario Tech. University and affiliated with Yildiz Technical University, and renowned for his pioneering works in the area of sustainable energy technologies he has authored/co-authored numerous books and book chapters, and many refereed journal and conference papers. He has chaired many national and international conferences, symposia, workshops and technical meetings. He has delivered many keynotes and invited lectures. He is an active member of various international scientific organizations and societies, and serves as editor-in-chief, associate editor, regional editor, and editorial board member on various prestigious international journals. He is a recipient of several research, teaching and service awards, including the Premier's research excellence award in Ontario, Canada. During the past seven years he has been recognized by Thomson Reuters as one of the Most Influential Scientific Minds in Engineering and one of the most highly cited researchers.

Özet

Bu bölüm çevresel sorunlarla mücadelede birincil çözüm yolları olarak tanınan güneş, jeotermal, rüzgâr, hidro, okyanus ve biyokütle kaynaklarını da içeren çeşitli yenilenebilir kaynaklardan enerji üretimini incelemektedir. Temel olarak, termal ve elektriksel başta olmak üzere çeşitli formlardaki enerji üretiminde yenilenebilir enerjinin rolünü tartışmaktadır. Ayrıca, yenilenebilir enerji sistemlerini ve uygulamalarını, temel ögelerinden başlayarak ileri teknolojiyi, tekniği ve operasyonel detayları birçok açıklayıcı örnek, problem ve uygulama aracılığıyla ele almaktadır. Söz konusu yenilenebilir enerji sistem ve uygulamalarının performanslarını enerji ve ekserji yaklaşımlarıyla işlemektedir. Yenilenebilir enerji sistemleri, teknik, sürdürülebilirlik ve çevresel etki açılarından değerlendirilmektedir. Kapsamlı bir uygulama çalışması, iki farklı yenilenebilir kaynağın multijenerasyon amacıyla entegre edilmesinin etkilerini ve entegre sistemin farklı dizayn ve operasyon koşullarında nasıl performans sergileyeceğinin araştırılması amacıyla bu çalışmaya dahil edilmiştir.

Anahtar kelimeler

Jeotermal Enerji; Rüzgâr Enerjisi; Hidroelektrik, Okyanus Enerjisi; Biyokütle Enerjisi; Güneş Enerjisi; Entegre Sistemler; Verim; Enerji; Ekserji

Abstract

This chapter discusses the primary roles of solar, geothermal, wind, hydro, ocean and biomass energies in combating environmental challenges. The energy sources are treated particularly in the forms of thermal and electrical. The chapter also covers the fundamental aspects, technological dimensions, operational details, examples and practical applications of renewable energy systems. The performances of such systems are evaluated through energy and exergy approaches. The renewable energy systems are also evaluated from various technical, environmental and sustainability perspectives. Furthermore, a case study is presented for an integrated multigenerational energy system to specifically study its design, operational conditions and performance criteria.

Keywords

Geothermal Energy; Wind Energy; Hydroelectric; Ocean Energy; Biomass Energy; Solar Energy; Integrated Systems; Efficiency; Energy; Exergy.

4.14. KAYNAKLAR / REFERENCES

[1] International Energy Agency (IEA). Key World Energy Statistics 2016. 2016. doi:10.1787/key_energ_stat-2016-en.

[2] REN21. Renewables 2016 Global status report. 2016.

[3] IRENA. Renewable Energy Capacity Statistics 2017. Abu Dhabi: 2017.

[4] Dickson M, Fanelli M. Geothermal Energy Utilization and Technology. UNESCO Publishing; 2005.

[5] Stacey FD, Loper DE. Thermal history of the Earth: a corollary concerning non-linear mantle rheology. Phys Earth Planet Inter 1988;53:167–74.

[6] Bronicki LY. Geothermal power conversion technology. In: Meyers RA, editor. Encycl. Sustain. Sci. Technol., New York, NY: Springer New York; 2012, p. 4234–339..

[7] Muffler P, Cataldi R. Methods for regional assessment of geothermal resources. Geothermics 1978;7:53–89.

[8] Hochstein MP. Assessment and modelling of geothermal reservoirs (small utilization schemes). Geothermics 1988;17:15–49.

[9] Benderitter Y, CORMY G. Possible Approach to Geothermal Research and Relative Cost Estimate. In: Dickson M, Fanelli M, editors. Small Geotherm. Resour. Guid. to Dev. Util., 1990, p. 61–71.

[10] Nicholson K. Geothermal Systems. Geotherm. Fluids, Berlin, Heidelberg: Springer Berlin Heidelberg; 1993, p. 1–18.

[11] Axelsson G, Gunnlaugsson E. Long-Term monitoring of high-And low-enthalpy fields under exploration. World Geotherm. Congr. 2000 Short Course, Japan: 2000.

[12] Sanyal S. Classification of geothermal systems – a possible Scheme. Thirtieth Work. Geotherm. Reserv. Eng., California, USA: 2005.

[13] Dinçer İ, Zamfirescu C. Renewable Energies. Sustain. Energy Syst. Appl., Boston, MA: Springer US; 2011, p. 283–387.

[14] DiPippo R. Larderello Dry-Steam Power Plants, Tuscany, Italy. Geotherm. Power Plants, 2008, p. 255–75.

[15] Ratlamwala TAH, Dincer I. Energetic and exergetic investigation of novel multi-flash geothermal systems integrated with electrolyzers. J Power Sources 2014;254:306–15.

[16] Ratlamwala TAH, Dincer I. Comparative efficiency assessment of novel multi-flash integrated geothermal systems for power and hydrogen production. Appl Therm Eng 2012;48:359–66.

[17] Lund JW. Geothermal Heat Pumps - Trends and Comparisons. Center, Geo-Heat Q Bull 1989;11:1–6.

[18] Chiasson A. Geothermal Energy Utilization in Ethanol Production. GHC Bull 2007.

[19] Fleming PD, Probert SD. The evolution of wind-turbines: An historical review. Appl Energy 1984;18:163–77.

[20] Kaldellis JK, Zafirakis D. The wind energy (r)evolution: A short review of a long history. Renew Energy 2011;36:1887–901.

[21] GWEC. Global Wind Report 2015 Gwec. 2016.

[22] Cengel YA, Boles MA. Thermodynamics: an engineering approach. vol. 1056. eight. McGraw Hill Education; 2014.

[23] Beaufort Scale | Royal Meteorological Society n.d. https://www.rmets.org/weather-and-climate/observing/beaufort-scale (accessed June 1, 2017).

[24] Dornier Darrieus 55 - 55,00 kW - Wind turbine n.d. https://en.wind-turbine-models.com/turbines/93-dornier-darrieus-55 (accessed July 31, 2017).

[25] Quiet Revolution Wind Turbine Photos n.d. https://www.quietrevolution.com/photos/ (accessed July 31, 2017).

[26] Dincer I, Rosen MA. Thermodynamic aspects of renewables and sustainable development. Renew Sustain Energy Rev 2005;9:169–89.

[27] CRESSMAN GP. AN OPERATIONAL OBJECTIVE ANALYSIS SYSTEM. Mon Weather Rev 1959;87:367–74.

[28] Barnes SL, Barnes SL. A Technique for Maximizing Details in Numerical Weather Map Analysis. J Appl Meteorol 1964;3:396–409.

[29] Schlatter TW. Past and Present Trends in the Objective Analysis of Meteorological Data for Nowcasting and Numerical Forecasting. Eighth Conf. Numer. Weather Predict., American Meteorological Society; 1988, p. 9–25.

[30] Şahin AD, Dincer I, Rosen MA. New Spatio-Temporal Wind Exergy Maps. J Energy Resour Technol 2006;128:194.

[31] NHA. History of Hydro | National Hydropower Association 2014. http://www.hydro.org/tech-and-policy/history-of-hydro/ (accessed June 11, 2017).

[32] International Hydropower Association. Hydropower Status Report. 2017.

[33] Hydropower| International Energy Agency n.d. doi:10.1006/rwos.2001.0031.

[34] United States Department of Energy. Types of Hydropower Plants | Department of Energy n.d. http://energy.gov/eere/water/types-hydropower-plants (accessed June 17, 2017).

[35] Majumder M, Ghosh S. Hydropower Plants. Decis. Mak. Algorithms Hydro-Power Plant Locat., 2013, p. 15–9.

[36] Kumar A, Schei T, Ahenkorah A, Caceres Rodriguez R, Devernay J-M, Freitas M, et al. Hydropower. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.: 2011.

[37] Wagner H-J, Mathur J. Hydraulic Turbines: Types and Operational Aspects. Introd. to Hydro Energy Syst., 2011, p. 71–93.

[38] Pelton Turbines | hydroenergy n.d. https://hydroenergy.pro/en/pelton-turbines/ (accessed July 31, 2017).

[39] HHF turbines – spiral Francis turbines - Small hydro power n.d. http://www.hydrolink.cz/en/francis-turbines/hhf-turbines-spiral-francis-turbines-12.html (accessed July 31, 2017).

[40] Zeco. Kaplan Turbine - Zeco Hydropower 2012. https://www.zeco.it/zeco-turbinas/turbina-kaplan?lang=es%5Cnhttps://www.zeco.it/zeco-turbines/kaplan-turbine/ (accessed July 31, 2017).

[41] Wagner H-J, Mathur J. Components of Hydropower Plants. Introd. to Hydro Energy Syst., 2011, p. 49–70.

[42] Burman K, Walker A. Ocean Energy Technology Overview. 2009.

[43] AEA Energy & Environment. Review and analysis of ocean energy systems development and supporting policies. 2006.

[44] OES. Implementing Agreement on Ocean Energy Systems - Annual Report. 2012.

[45] Technologies RE. Marine & Ocean Energy Development An Introduction for Practitioners in APEC Economies. 2013.

[46] B K Hodge. Alternative energy systems and applications. 2010.

[47] Masutani SM, Takahashi PK. Ocean Thermal Energy Conversion (OTEC). 2001.

[48] Avery WH, Richards D, Dugger GL. Hydrogen generation by OTEC, and economical energy transfer to world markets via ammonia and methanol. Int J Hydrogen Energy 1985;10:727–36.

[49] PATTLE RE. Production of Electric Power by mixing Fresh and Salt Water in the Hydroelectric Pile. Nature 1954;174:660–660.

[50] Yip NY, Elimelech M. Thermodynamic and energy efficiency analysis of power generation from natural salinity gradients by pressure retarded osmosis. Environ Sci Technol 2012;46:5230–9.

[51] Post JW, Veerman J, Hamelers HVM, Euverink GJW, Metz SJ, Nymeijer K, et al. Salinity-gradient power: Evaluation of pressure-retarded osmosis and reverse electrodialysis. J Memb Sci 2007;288:218–30.

[52] Veerman J. Reverse electro-dialysis, design and optimization by modelling and experimentation. University of Groningen, Netherlands, 2010.

[53] IRENA IREA-. Tidal Energy Technology Brief. 2014.

[54] Twidell J, Weir T. Renewable Energy Resources. 2nd ed. Abingdon, UK: Taylor & Francis; 2006.

[55] EMEC. European Marine Energy Centre – Tidal devices 2016. http://www.emec.org.uk/marine-energy/tidal-devices/ (accessed July 16, 2017).

[56] Gunn K, Stock-Williams C. Quantifying the global wave power resource. Renew Energy 2012;44:296–304.

[57] Modelon Cross tidal kites n.d. http://www.modelon.com/blog/articles/cross-tidal-kites/ (accessed July 31, 2017).

[58] Marsh G. Wave and tidal power – an emerging new market for composites - Renewable Energy Focus. Renew Energy Focus 2009. http://www.renewableenergyfocus.com/view/1710/wave-and-tidal-power-an-emerging-new-market-for-composites/ (accessed July 31, 2017).

[59] Wave Dragon Pre-Commercial Demonstration Project | Tethys n.d. https://tethys.pnnl.gov/annex-iv-sites/wave-dragon-pre-commercial-demonstration-project (accessed July 31, 2017).

[60] World Energy Council. World Energy Resources Bioenergy 2016. 2016.

[61] Loo S Van, Koppejan J. The handbook of biomass combustion and co-firing. vol. 1. Earthscan; 2008.

[62] Szargut J. Exergy Method, Technical and Ecological Applications. WIT Press, Boston; 2005.

[63] Dincer İ, Zamfirescu C. Renewable Energies. Sustain. Energy Syst. Appl., Boston, MA: Springer US; 2011, p. 283–387.

[64] Colpan CO, Hamdullahpur F, Dincer I, Yoo Y. Effect of gasification agent on the performance of solid oxide fuel cell and biomass gasification systems. Int J Hydrogen Energy 2010;35:5001–9.

[65] Zamfirescu C, Dincer I. How much exergy one can obtain from incident solar radiation? J Appl Phys 2009;105:44911.

[66] Markvart T, Landsberg PT. Thermodynamics and reciprocity of solar energy conversion. Phys E Low-Dimensional Syst Nanostructures 2002;14:71–7.

[67] NASA's Climate Kids :: Tower of Power n.d. http://climatekids.nasa.gov/concentrating-solar/ (accessed July 29, 2017).

[68] Dincer I. Potential options to greenize energy systems. Sixth Int. green energy Conf., Eskisehir, Turkey: 2011.

[69] Dincer I, Acar C. Smart energy systems for a sustainable future. Appl Energy 2016;194:1–11.

[70] Dincer I, Acar C. A review on clean energy solutions for better sustainability. Int J Energy Res 2015;39:585–606.

[71] Edenhofer O, Pichs-Madruga R, Sokona Y, Seyboth K, Eickemeier P, Matschoss P, et al. IPCC, 2011: Summary for Policymakers. In: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. 2011.

[72] Bazmi AA, Zahedi G. Sustainable energy systems: Role of optimization modeling techniques in power generation and supply - A review. Renew Sustain Energy Rev 2011;15:3480–500.

[73] Pembina Institute T. Estimating the Non-Air Environmental Benefits of Renewable Power Sources 2008.

[74] Aman MM, Solangi KH, Hossain MS, Badarudin A, Jasmon GB, Mokhlis H, et al. A review of Safety, Health and Environmental (SHE) issues of solar energy system. Renew Sustain Energy Rev 2015;41:1190–204.

[75] IEA (International Energy Agency). Renewables for heating and cooling. 2007.

[76] Parry M, Canziani O, Palutikof J, Van der Liden P, Hanson C. Climate Change 2007: Impacts, Adaptation and Vulnerability. 2007.

[77] Hacatoglu K, Rosen MA, Dincer I. Comparative life cycle assessment of hydrogen and other selected fuels. Int J Hydrogen Energy 2012;37:9933–40.

[78] Acar C, Dincer I. Comparative assessment of hydrogen production methods from renewable and non-renewable sources. Int J Hydrogen Energy 2014;39:1–12.

[79] Cetinkaya E, Dincer I, Naterer GF. Life cycle assessment of various hydrogen production methods. Int J Hydrogen Energy 2012;37:2071–80.

[80] Ozbilen A, Dincer I, Rosen MA. Comparative environmental impact and efficiency assessment of selected hydrogen production methods. Environ Impact Assess Rev 2013;42:1–9.

[81] Dincer I, Rosen MA. Chapter 14 - Exergy Analysis of Integrated Trigeneration and Multigeneration Systems. Exergy Second Ed., 2013, p. 303–17.

[82] Dincer I, Zamfirescu C. Renewable-energy-based multigeneration systems. Int J Energy Res 2012;36:1403–15.

[83] Khalid F, Dincer I, Rosen MA. Techno-economic assessment of a renewable energy based integrated multigeneration system for green buildings. Appl Therm Eng 2016;99:1286–94.

[84] Ezzat MF, Dincer I. Energy and exergy analyses of a new geothermal-solar energy based system. Sol Energy 2016;134:95–106.

[85] Al-Zareer M, Dincer I, Rosen MA. Development and assessment of a new solar heliostat field based system using a thermochemical water decomposition cycle integrated with hydrogen compression. Sol Energy 2017;151:186–201.

[86] Ahmadi P, Dincer I, Rosen M a. Performance Assessment of a Novel Solar and Ocean Thermal Energy Conversion Based Multigeneration System for Coastal Areas. J Sol Energy Eng 2014;137:11013.

[87] Ghosh S, Dincer I. Development and analysis of a new integrated solar-wind-geothermal energy system. Sol Energy 2014;107:728–45.

[88] Khalid F, Dincer I, Rosen MA. Energy and exergy analyses of a solar-biomass integrated cycle for multigeneration. Sol Energy 2015;112:290–9.

[89] Malik M, Dincer I, Rosen MA. Development and analysis of a new renewable energy-based multi-generation system. Energy 2015;79:90–9.

[90] Kanase-Patil AB, Saini RP, Sharma MP. Integrated renewable energy systems for off grid rural electrification of remote area. Renew Energy 2010;35:1342–9.

[91] Amusat OO, Shearing PR, Fraga ES. Optimal integrated energy systems design incorporating variable renewable energy sources. Comput Chem Eng 2016;95:21–37.

[92] Laboratory LBN, Information USD of EO of S and T. Proceedings: Third Symposium on the Cerro Prieto Geothermal Field, Baja California, Mexico. Lawrence Berkeley National Laboratory; 1981.

[93] The Dow Chemical Company. DOWTHERM Q Heat Transfer Fluid 1997.

[94] Department of Energy. Next-Generation Wind Technology | Department of Energy n.d. https://energy.gov/eere/next-generation-wind-technology (accessed August 4, 2017).

[95] The Biggest Clean Energy Advances in 2016 - MIT Technology Review n.d. https://www.technologyreview.com/s/603275/the-biggest-clean-energy-advances-in-2016/ (accessed August 4, 2017).

İlgili Kitaplar

1- Dinçer İ, Zamfirescu C. Sustainable Energy Systems and applications. Boston, Springer US; 2011.

2- B K Hodge. Alternative Energy Systems and Applications. 2010.

3- Dincer I, Rosen MA. Exergy: Energy, Environment and sustainable development, Second Ed., Elsevier, 2013.

4- Cengel YA, Boles MA. Thermodynamics: an engineering approach. Eight Ed., McGraw Hill Education; 2014.

5- Dinçer İ, Zamfirescu C. Advanced Power Generation System. First Ed., Elsevier, 2014.