

OVERVIEW OF SHALLOW GEOTHERMAL ENERGY SYSTEMS IN URBAN ENVIRONMENTS

SGE is ubiquitous, available any time, weather independent, efficient and renewable

From 0 to 200 m under the surface (exceptionally up to 400 m)

Stored/exchanged in/with the subsurface

Heat extracted/injected from/to the subsurface with (or without) HEAT PUMPS

SHALLOW GEOTHERMAL ENERGY

1. IEA, "Energy Technology Perspectives" (2010)
2. PEI, Netherlands Environmental Assessment Agency, "Heat and Figures on Cities and Urban Areas" (2002)
3. Future Electricity, E. ATO 2006 (2002)
4. BP, "International Review of World Energy" (2002)
5. Farnsworth G.L. & Schmitt G.L., "Renewables" (2nd ed. 2002)

The Sun is the true main source of SGE

Average solar radiation absorbed at the Earth's surface¹⁾
165 W/m²

World human average power consumption²⁾
→ **34 mW/m²**

Average power reaching the Earth crust from its internal heat budget³⁾
40-90 mW/m²
Average value in continental areas
→ **65 mW/m²**

64 % of world primary energy is consumed in urban areas⁴⁾

72 % of EU population lives in urban areas⁵⁾

70 % of world CO₂ emissions are concentrated in cities⁶⁾

17 % of EU land is considered as "urban"⁷⁾

OL-SWHEs, CL-SWHEs

Large water bodies like rivers, lakes and the sea show a reduced yearly temperature variation compared to air. Good option for free cooling.

Vertical BHEs, BTES

The geo-exchange within the ground using close loop systems (CL).

Almost constant temperature along the year (10-18°C) below 10m depth to 100-200 m

T_{ground} is determined by solar radiation close to the surface. Afterwards, the geothermal gradient prevails.

CTES, BTES, ATES

Excess heat from solar collectors (>100°C) to ground storage

GSHP
Ground Source Heat Pump

Excess heat from sewer network is usually lost (wastewater >10°C)

Excess heat from the industry (>100°C). Good option for free heating

Industrial
Wastewater

Wastewater
Heating and cooling grids

Groundwater
Heat exchangers

SGE-based DHC networks

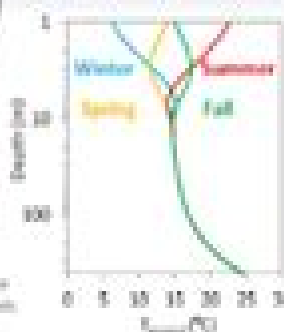
District heating and cooling systems powered with SGE technologies or combined with other RES or waste heat sources

Vertical GWHEs

Vertical GWHEs

The groundwater exchange abstracting and injecting groundwater from the aquifers

Excess heat from underground infrastructures causes cumulative ground warming and warm air at tunnels (>150°C)



Heat exchanger can be embedded in deep foundations (>10 m)

TAFs

Energy Concepts And Challenges

Michael Seilmaier



Energy Concepts And Challenges:

ICT - Energy Concepts for Energy Efficiency and Sustainability Giorgos Fagas, Luca Gammaitoni, John P. Gallagher, Douglas Paul, 2017-03-22 In a previous volume *ICT Energy Concepts Towards Zero Power ICT* referenced below as Vol 1 we addressed some of the fundamentals related to bridging the gap between the amount of energy required to operate portable mobile ICT systems and the amount of energy available from ambient sources The only viable solution appears to be to attack the gap from both sides i.e. to reduce the amount of energy dissipated during computation and to improve the efficiency in energy harvesting technologies In this book we build on those concepts and continue the discussion on energy efficiency and sustainability by addressing the minimisation of energy consumption at different levels across the ICT system stack from hardware to software as well as discussing energy consumption issues in high performance computing HPC data centres and communication in sensor networks This book was realised thanks to the contribution of the project Coordinating Research Efforts of the ICT Energy Community funded from the European Union under the Future and Emerging Technologies FET area of the Seventh Framework Programme for Research and Technological Development grant agreement n 611004

Innovations and challenges of the energy transition in smart city districts Sven Leonhardt, Tobias Nusser, Jürgen Görres, Sven Rosinger, Gerhard Stryi-Hipp, Martin Eckhard, 2023-12-31 As living economic and cultural spaces cities require a sustainable energy system and must be designed to be highly energy efficient The book provides a framework for practitioners and scientists on how the energy transition can contribute to achieving climate goals in the building sector Innovations and creative approaches for solutions from the lighthouse projects of the Solar Building Energy Efficient City funding initiative are presented

Teaching and Learning of Energy in K - 12 Education Robert F. Chen, Arthur Eisenkraft, David Fortus, Joseph Krajcik, Knut Neumann, Jeffrey Nordine, Allison Scheff, 2014-04-09 This volume presents current thoughts research and findings that were presented at a summit focusing on energy as a cross cutting concept in education involving scientists science education researchers and science educators from across the world The chapters cover four key questions what should students know about energy what can we learn from research on teaching and learning about energy what are the challenges we are currently facing in teaching students this knowledge and what needs be done to meet these challenges in the future Energy is one of the most important ideas in all of science and it is useful for predicting and explaining phenomena within every scientific discipline The challenge for teachers is to respond to recent policies requiring them to teach not only about energy as a disciplinary idea but also about energy as an analytical framework that cuts across disciplines Teaching energy as a crosscutting concept can equip a new generation of scientists and engineers to think about the latest cross disciplinary problems and it requires a new approach to the idea of energy This book examines the latest challenges of K 12 teaching about energy including how a comprehensive understanding of energy can be developed The authors present innovative strategies for learning and teaching about energy revealing overlapping and diverging views from

scientists and science educators The reader will discover investigations into the learning progression of energy how understanding of energy can be examined and proposals for future directions for work in this arena Science teachers and educators science education researchers and scientists themselves will all find the discussions and research presented in this book engaging and informative

The fusion energy program the role of TPX and alternate concepts. , **FY 1996 DOE, EPA, and NOAA R&D Budget Authorizations** United States. Congress. House. Committee on Science. Subcommittee on Energy and Environment,1995

Renewable and Alternative Energy: Concepts, Methodologies, Tools, and Applications Management Association, Information Resources,2016-10-19 As the human population expands and natural resources become depleted it becomes necessary to explore other sources for energy consumption and usage Renewable and Alternative Energy Concepts Methodologies Tools and Applications provides a comprehensive overview of emerging perspectives and innovations for alternative energy sources Highlighting relevant concepts on energy efficiency current technologies and ongoing industry trends this is an ideal reference source for academics practitioners professionals and upper level students interested in the latest research on renewable energy

Sustainable Development: Concepts, Methodologies, Tools, and Applications Management Association, Information Resources,2017-10-31 To maintain a healthy ecosystem for contemporary society and for future generations policies must be implemented to protect the environment This can be achieved by consistent evaluation of new initiatives and strategies Sustainable Development Concepts Methodologies Tools and Applications is a comprehensive source of scholarly information on the latest research for sustainability concerns across a multidisciplinary perspective Highlighting a broad range of innovative topics such as renewable energy urban development and green technologies this multi volume book is ideally designed for academics researchers professionals students and practitioners interested in the preservation of the environment

Innovation Development for Highly Energy-Efficient Housing E. Mlecnik,IOS Press,2013-03-20 In previous years we have seen a recognition of the significant potential that exists for reducing energy use through innovation in residential buildings This study investigates innovation challenges and identifies opportunities that could lead to a rapid increase in the adoption of highly energy efficient housing concepts particularly that of the passive house To this end it exemplifies interprets and develops the innovation adoption theory through an investigation of views and experiences on the supply side the demand side and the policy side It highlights successful innovation trajectories and barriers experienced by businesses It addresses both problems and positive experiences from the perspective of the end user and investigates different policy approaches As such the research reveals important features of innovation adoption strategies in the building sector It shows how multi player enterprise collaboration plays a key role and the study also recommends the development of quality assurance schemes It makes a valuable contribution to discussions about how active the role of government policymakers and enterprise networks should be

Societal Challenges and Opportunities of Low-Carbon Energy Transformations Dalia Streimikiene,2025-04-17 Low carbon

energy transformations to support carbon neutral societies is an important and urgent topic and subject to current national priorities and socio economic planning This book addresses the societal challenges and opportunities that come with the transition in EU member states such as energy poverty and inequality energy security gender inequality energy efficiency improvements climate change mitigation growth in green investments etc It contains a balanced approach of theoretical concepts with an impressive range of relevant case studies to investigate the issues develop indicator frameworks identify barriers and drivers and create policies and measures to unlock opportunities Features Addresses systematically and comprehensively the low carbon energy transition its barriers and its societal implications Discusses the main societal challenges and opportunities of low carbon energy transition from theoretical and practical points of view Provides definitions of concepts measurement indicators policies and a framework for overcoming barriers and enforcing drivers Includes case studies on low carbon energy transition challenges and opportunities that are developed for EU countries Encourages discussion on policies and measures necessary to overcome identified barriers and proposes how to promote a just and smooth low carbon energy transition This book is a great reference for academics researchers graduate students and professionals such as energy producers city planners policymakers etc interested in current and emerging trends in sustainable energy

The Oxford Handbook of Energy Politics Kathleen J. Hancock, Juliann Emmons Allison, 2020-12-02 The global regional and local energy landscape has changed dramatically in the twenty first century Many factors have affected what we know about energy a consensus among scientists on climate change and related support for renewable energy evolving energy and resource extraction technologies growing resource demand in the developing world new regional and global energy governance actors new major fossil fuel discoveries on land and underwater in states that have previously been under resourced rising interest in corporate social responsibility in energy companies and the need for energy justice The Oxford Handbook of Energy Politics synthesizes the diverse literature on these topics to provide a foundational resource for teaching and research on critical energy issues in international relations and comparative politics Through chapters authored by both scholars and practitioners the Handbook further develops the energy politics scholarship and community and generates sophisticated new work that will benefit all who work on energy issues

Demand-Side Peer-to-Peer Energy Trading Vahid Vahidinasab, Behnam Mohammadi-Ivatloo, 2023-08-01 Demand Side Peer to Peer Energy Trading provides a comprehensive study of the latest developments in technology protocols implementation and application of peer to peer and transactive energy concepts in energy systems and their role in worldwide energy evolution and decarbonization efforts It presents practical aspects and approaches with evidence from applications to real world energy systems through in depth technical discussions use cases and examples This multidisciplinary reference is suitable for researchers and industry stakeholders who focus on the field of energy systems and energy economics as well as researchers and developers from different branches of engineering energy computer sciences data economic and operation research fields

Beiträge Zur

15. Internationalen Konferenz Zu Stadtplanung, Regionalentwicklung und Informationsgesellschaft Manfred Schrenk, 2010 [Energy Poverty and Access Challenges in Sub-Saharan Africa](#) Victoria R. Nalule, 2018-08-27 Access to modern energy is central in addressing the major global challenges of the 21st century including poverty climate change and famine However large parts of the world especially in Sub Saharan Africa SSA have poor or no access to modern energy Victoria Nalule argues that SSA countries have many common energy challenges which could be tackled with collective efforts through regional cooperation By means of a legal and comparative analysis and a seven step framework the book explores the current regional mechanisms employed in Africa to address the challenge of energy poverty and access and whether they are effective in tackling the challenge of energy access including regional energy infrastructure and regional energy regulations Chapters discuss the evolution of regionalism in SSA and the role of regional cooperation in the development of renewable energy as a means of confronting both energy access and climate change Specifically the nexus between energy access renewable energy and climate change is covered as well as the potential of fossil fuels in addressing energy poverty The establishment and development of regional energy infrastructure as one of the mechanisms of addressing energy access challenges in SSA and regional efforts to harmonise energy regulation are explored Finally a concluding chapter provides recommendations for policy makers and other relevant stakeholders on how best to implement some of the suggestions made in previous chapters International organisations regional organisations government officials scholars and students with interest in the energy sector will highly benefit from this book

AI and IoT: Driving Business Success and sustainability in the Digital Age Bahaa Awwad, 2025-08-11 This book explores the integration of AI technologies with emerging trends such as IoT blockchain and cloud computing In this book readers will embark on a transformative journey that explores the powerful convergence of Artificial Intelligence AI Internet of Things IoT and business management With the advent of these cutting edge technologies businesses have unprecedented opportunities to revolutionize their operations drive innovation and achieve remarkable success in today s digital landscape

Computational Science and Its Applications - ICCSA 2023 Workshops Osvaldo Gervasi, Beniamino Murgante, Ana Maria A. C. Rocha, Chiara Garau, Francesco Scorza, Yeliz Karaca, Carmelo M. Torre, 2023-06-28 This nine volume set LNCS 14104 14112 constitutes the refereed workshop proceedings of the 23rd International Conference on Computational Science and Its Applications ICCSA 2023 held at Athens Greece during July 3 6 2023 The 350 full papers and 29 short papers and 2 PHD showcase papers included in this volume were carefully reviewed and selected from a total of 876 submissions These nine volumes includes the proceedings of the following workshops Advances in Artificial Intelligence Learning Technologies Blended Learning STEM Computational Thinking and Coding AAILT 2023 Advanced Processes of Mathematics and Computing Models in Complex Computational Systems ACMC 2023 Artificial Intelligence supported Medical data examination AIM 2023 Advanced and Innovative web Apps AIWA 2023 Assessing Urban Sustainability ASUS 2023 Advanced Data Science Techniques with

applications in Industry and Environmental Sustainability ATELIERS 2023 Advances in Web Based Learning AWBL 2023 Blockchain and Distributed Ledgers Technologies and Applications BDLTA 2023 Bio and Neuro inspired Computing and Applications BIONCA 2023 Choices and Actions for Human Scale Cities Decision Support Systems CAHSC DSS 2023 and Computational and Applied Mathematics CAM 2023 *The Palgrave Handbook of Managing Fossil Fuels and Energy Transitions* Geoffrey Wood, Keith Baker, 2019-11-12 This Handbook is the first volume to comprehensively analyse and problem solve how to manage the decline of fossil fuels as the world tackles climate change and shifts towards a low carbon energy transition The overall findings are straight forward and unsurprising although fossil fuels have powered the industrialisation of many nations and improved the lives of hundreds of millions of people another century dominated by fossil fuels would be disastrous Fossil fuels and associated greenhouse gas emissions must be reduced to a level that avoids rising temperatures and rising risks in support of a just and sustainable energy transition Divided into four sections and 25 contributions from global leading experts the chapters span a wide range of energy technologies and sources including fossil fuels carbon mitigation options renewables low carbon energy energy storage electric vehicles and energy sectors electricity heat and transport They cover varied legal jurisdictions and multiple governance approaches encompassing multi and inter disciplinary technological environmental social economic political legal and policy perspectives with timely case studies from Africa Asia Australia Europe North America South America and the Pacific Providing an insightful contribution to the literature and a much needed synthesis of the field as a whole this book will have great appeal to decision makers practitioners students and scholars in the field of energy transition studies seeking a comprehensive understanding of the opportunities and challenges in managing the decline of fossil fuels **The Challenge for Energy Justice** Raphael J Heffron, 2021-10-26 Written by one of the world s leading scholars in the field this book provides a unique perspective on the connections between energy justice and human rights Taking an interdisciplinary approach the author offers an accessible discussion about the implementation of energy justice in practice The book explores the rise of justice issues in the energy sector the interdisciplinary nature of energy justice the economics of energy justice and provides a practical case study on distributive justice The penultimate chapter focuses on human rights and energy justice in a world first and explores the topic from the perspective of the opportunity of last resort This opportunity of last resort is the national courts and is the place where societies can seek to have justice enforced through a variety of human rights being protected Finally energy justice risks are highlighted alongside the author s proposed framework for the next generation of energy justice scholars

Urban Energy Systems Deepak Kumar, 2023-08-29 URBAN ENERGY SYSTEMS With climate change and energy issues infiltrating seemingly every aspect of our lives it is more important than ever to continue the march toward sustainability It is not just about switching to a gasoline free car or installing solar panels Many countries including our own are dealing with these very difficult problems by converting to smart cities and other green energy projects This is perhaps one of the most

important issues facing our world today Urban energy systems play a critical role in the sustainability and resilience of smart cities As cities continue to grow and face increasing energy demands it becomes essential to develop efficient and sustainable energy solutions Modelling and simulation techniques provide valuable insights into the design operation and optimization of urban energy systems supporting the transition towards more sustainable and smart cities This perspective highlights the importance of modelling and simulation in achieving sustainable urban energy systems and their role in shaping smart cities Modelling and simulation play a crucial role in achieving sustainable urban energy systems and shaping smart cities By integrating diverse energy systems optimizing renewable energy integration enabling demand side management supporting microgrid and storage system design enhancing resilience and facilitating policy evaluation these tools empower decision makers to develop and implement sustainable energy solutions Embracing a modelling and simulation perspective in urban energy planning supports the transition towards more sustainable efficient and resilient smart cities that meet the energy needs of present and future generations This book uncovers the latest research in the field of urban energy sustainability and climate management Urban energy sustainability and climate management have been employed successfully for various purposes like human computer interaction decision making recommender systems and so on Data analytics have supported these applications through various efficient and effective methods Covering all of these topics this is a one stop shop for engineers students policymakers scientists and other industry professionals working with smart cities and urban energy systems It is a must have for any library

Architectural Research Addressing Societal Challenges Manuel Jorge Rodrigues Couceiro da Costa,Filipa Roseta,Joana Pestana Lages,Susana Couceiro da Costa,2019-08-08 The escalating interdependency of nations drives global geopolitics to shift ever more quickly Societies seem unable to control any change that affects their cities whether positively or negatively Challenges are global but solutions need to be implemented locally How can architectural research contribute to the future of our changing society How has it contributed in the past The theme of the 10th EAAE ARCC International Conference Architectural Research Addressing Societal Challenges was set to address these questions This book Architectural Research Addressing Societal Challenges includes reviewed papers presented in June 2016 at the 10th EAAE ARCC International Conference which was held at the facilities of the Faculty of Architecture of the University of Lisbon The papers have been further divided into the following five sub themes a Changing Society In Transit Global Migration Renaturalization of the City Emerging Fields of Architectural Practice and Research on Architectural Education The EAAE ARCC International Conference held under the aegis of the EAAE and of the ARCC is a conference organized every other year in collaboration with one of the member schools universities of those associations alternatively in North America or in Europe From Economic to Energy Transition Matúš Mišík,Veronika Oravcová,2020-09-28 This book examines energy transition issues within the Central and Eastern European CEE region The European Union is aiming for an almost complete decarbonization of its energy sector by 2050 However the

path towards a carbon free economy is full of challenges that must be solved by individual EU members Across 18 chapters leading researchers explore challenges related to energy transition and analyse individual EU members from Central and Eastern Europe as well as the region as a whole To further explore this complex issue the volume also includes several countries from South East Europe in its analysis As perspective members these countries will be important contributors to the EU s mid and long term climate and energy goals The focus on a variety of issues connected to energy transition and systematic analyses of the different CEE countries make it an ideal reference for anyone with a general interest in the region or European energy transition It will also be a useful resource for students looking for an accessible overview of the field

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Table of Contents Energy Concepts And Challenges

1. Understanding the eBook Energy Concepts And Challenges
 - The Rise of Digital Reading Energy Concepts And Challenges
 - Advantages of eBooks Over Traditional Books
2. Identifying Energy Concepts And Challenges
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Energy Concepts And Challenges
 - User-Friendly Interface
4. Exploring eBook Recommendations from Energy Concepts And Challenges
 - Personalized Recommendations
 - Energy Concepts And Challenges User Reviews and Ratings
 - Energy Concepts And Challenges and Bestseller Lists
5. Accessing Energy Concepts And Challenges Free and Paid eBooks
 - Energy Concepts And Challenges Public Domain eBooks
 - Energy Concepts And Challenges eBook Subscription Services
 - Energy Concepts And Challenges Budget-Friendly Options

6. Navigating Energy Concepts And Challenges eBook Formats
 - ePub, PDF, MOBI, and More
 - Energy Concepts And Challenges Compatibility with Devices
 - Energy Concepts And Challenges Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Energy Concepts And Challenges
 - Highlighting and Note-Taking Energy Concepts And Challenges
 - Interactive Elements Energy Concepts And Challenges
8. Staying Engaged with Energy Concepts And Challenges
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Energy Concepts And Challenges
9. Balancing eBooks and Physical Books Energy Concepts And Challenges
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Energy Concepts And Challenges
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Energy Concepts And Challenges
 - Setting Reading Goals Energy Concepts And Challenges
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Energy Concepts And Challenges
 - Fact-Checking eBook Content of Energy Concepts And Challenges
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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