

PERSONAL INFORMATION

Zack Norwood

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Date of birth 1979-06-08 | Nationality Sverige / USA

POSITION

Senior Researcher

EDUCATION AND TRAINING

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| 2008 - 2011 | <p>Doctor of Philosophy in energy and resources EQF level 8</p> <p>University of California, Berkeley, Energy and Resources Group, USA</p> <ul style="list-style-type: none"> ▪ Certificate in engineering and business for sustainability ▪ Dissertation: A better steam engine: Designing a distributed concentrating solar combined heat and power system ▪ Committee: Daniel Kammen, Robert Dibble, Duncan Callaway |
| 2007 - 2009 | <p>Master of Science in mechanical engineering EQF level 7</p> <p>University of California, Berkeley, Mechanical Engineering, USA</p> <ul style="list-style-type: none"> ▪ Thesis: Assessment of combined heat and power system “premium power” applications in California ▪ Supervisors: Tim Lipman, Chris Marnay |
| 2001 - 2002 | <p>Master of Science in electrical engineering systems EQF level 7</p> <p>University of Michigan, Ann Arbor, Electrical Engineering, USA</p> |
| 1997 - 2001 | <p>Bachelor of Science in electrical and computer engineering EQF level 6</p> <p>Rice University, Electrical and Computer Engineering, Houston, Texas, USA</p> |

RESEARCH EXPERIENCE

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| 2020 - present | <p>Senior researcher: Realistic local climate change time-series matched to climate policy goals (eg 1.5 °C)</p> <p>Göteborgs Universitet, Department of Earth Sciences, Göteborg, Sverige</p> <ul style="list-style-type: none"> ▪ Formas funded applied research to integrate climate change scenarios into an energy and building stock investment optimization model to look at the effects of climate change on possible development trajectories. ▪ Collaboration with Chalmers Tekniska Högskola to develop stepwise retrofit packages to existing building stock models to look at scenarios for how heating and electricity systems in countries with reliance on fossil fuels for space heating will likely change over time to meet climate goals. |
| 2017 - 2019 | <p>Senior researcher: Fossil Free Energy Districts</p> <p>Göteborgs Universitet / Johanneberg Science Park / Chalmers Tekniska Högskola, Göteborg, Sverige</p> <ul style="list-style-type: none"> ▪ A 3-year, 4.6 million euro EU UIA grant in collaboration with the City of Göteborg, Göteborg Energi, Akademiska Hus, Chalmers Fastigheter, RISE, Ericsson, Business Region Göteborg, and Johanneberg Science Park. Co-PI in collaboration with two other researchers responsible for a 490 thousand euro award to Chalmers. ▪ Lead researcher for the simulation and design of the investment optimization and dispatch model to be used to advise on physical investments in the campus infrastructure to achieve decreased carbon emissions and energy use from the campus building stock and energy systems. ▪ Lead researcher for developing the technical key performance indicators, including |

methodology for attributing life-cycle carbon emissions and primary energy to the campus energy systems.

2015 - 2017 **Senior researcher: Transforming Energy and Resources on Campus**

Chalmers Tekniska Högskola, Byggnadsteknologi, Göteborg, Sverige

- Developed a framework for modeling the Chalmers University Johanneberg campus to analyze scenarios for transitioning to a sustainable building stock based on European goals.
- PI for a proposal that was awarded 30 thousand euros from the Energy Area of Advance at Chalmers for evaluation of a million program passive house renovation with a building integrated PV facade and roof. Collaboration with RISE and Emulsionen.
- Co-PI for a 50 thousand euro project which in collaboration with HSB, Göteborg Energi, and Emulsionen has demonstrated building integrated PV facade and roof concepts on HSB Living Lab.

2013 - 2015 **Postdoctoral researcher**

Chalmers Tekniska Högskola, Energiteknik, Göteborg, Sverige

- Lead researcher on modelling the potential impact of solar technologies on the future European electricity grid for the Pathways for Sustainable European Energy Systems project. Results include development of an open source GIS modelling tool that can compare many distributed solar thermal, solar electric, and solar hybrid/CHP systems and analyse pathways of the future grid based on economic optimization constrained to climate goals.

2008 - 2011 **Graduate student researcher**

University of California, Berkeley, Energy and Resources Group, USA

- Conceived, wrote, and was awarded a two year, 260 thousand dollar grant in the Haas Sustainable Products and Solutions Program. Managed this distributed concentrating solar combined heat and power program from start to finish employing 4 graduate students, 5 undergraduates, and a staff mechanical engineer. Also brokered collaboration with industry partners United Technologies Research Center, RawSolar, and Katrinx, Inc.

2007 - 2008 **Graduate student researcher**

Lawrence Berkeley National Laboratory, Environmental Energy Technologies, Berkeley, California, USA

- Contracted by DOE Pacific Region Combined Heat and Power Application Center through the UC Berkeley Institute of Transportation Studies to evaluate economic models of distributed generation CHP for premium power applications.

2002 - 2007 **Electrical engineer**

Lawrence Livermore National Laboratory, Energy and Environment, Livermore, California, USA

- Research in thermodynamic and demand analysis of distributed solar thermal combined heat and power systems (Rankine and Stirling cycles).
- Research in homogenous charge compression ignition wet ethanol engines for use in stationary power generation and transportation.
- Engineer for the target diagnostics team and controls test team for the Integrated Computer Control System of the National Ignition Facility (NIF), a laser inertial confinement fusion project.

DEMO / OTHER PROJECTS

2013 - present **First Passive House Plus retrofit in Sweden**

Kollektivhuset Stacken, Göteborg, Sverige

- Project leader for a step-wise deep energy retrofit with a building integrated solar PV roof and facade to bring an apartment building to the international Passive House Plus standard with a quick return on investment without increasing tenant rents. Demonstration of what can be done with other million program buildings in Sweden.
- PI for grants of 420 thousand euros from the Swedish Energy Agency (Energimyndigheten), the Swedish Society for Nature Conservation (Naturskyddsföreningen), and the regional government (Västra Götalandsregionen and Länsstyrelsen) for a project of 1.2 million euros.
- As a member of the energy group in this 35 apartment building, managed installation of energy efficiency measures including insulation, air-sealing projects, LED lighting and water

saving measures.

- Included in the EU EuroPHit project to design and evaluate renovations of apartments to the International Passive House standard.

2011 - 2012 **First EnerPHit Passive House retrofit in the U.S.**

Wakefield, Rhode Island, USA

- Project leader who also modeled, and engineered all aspects of the renovation of a 30-year old single-family house, with passive-solar elements, solely from the exterior (minimal disruption of interior spaces and inhabitants), to reduce primary energy consumption by over 80%. This was the first Passive House retrofit in the State of Rhode Island and the first project in the United States to receive certification to the International Passive House EnerPHit standard. Total project size was approximately 60 thousand dollars.

2003 - 2011 **Founding affordable housing cooperatives**

Cooperative Roots, Berkeley, California, USA

- Founding director and CFO of a 501c(3) non-profit organization providing affordable, member-run shared houses. Project manager for deep building retrofits, solar thermal, solar photovoltaic, rainwater and greywater systems. Total project size was approximately 1.5 million dollars.

LANGUAGES

Mother tongue english

Other language(s)

	UNDERSTANDING		SPEAKING		WRITING
	Listening	Reading	Spoken interaction	Spoken production	
svenska	C1	C2	C2	C1	C2
français	B2	B2	B2	B1	B1
español	A2	A2	A1	A1	A1

Levels: A1/2: Basic user - B1/2: Independent user - C1/2 Proficient user
Common European Framework of Reference for Languages

SCIENTIFIC PUBLICATIONS

Selected peer reviewed publications after PhD dissertation

- Alavijeh, Nima M, David Steen, Zack Norwood, Anh Tuan Lee, Christos Agathokleous. "Cost-Effectiveness of Carbon Emission Abatement Strategies for a Local Multi-Energy System—A Case Study of Chalmers University of Technology Campus. *Energies*". 2020; 13(7):1626.
- Norwood, Zack, and Anne Andersson. "PV Quality Issues Applying Building Integrated Photovoltaics (BIPV) on the Façade and Roof When Deep Renovating a 50 Year Old Apartment Building", *Proceedings of the 35th EU PVSEC* (2018), 1448 - 1451. Brussels, Belgium, 2018.
- Norwood, Zack, Dan-Eric Archer, and Ingo Theoboldt. "Evaluation of a step-by-step million program deep retrofit to passive house with building integrated PV roof and façade", *Conference proceedings of the 22nd annual passive house conference*. München, Germany, 2018.
- Norwood, Zack, Joel Goop, and Mikael Odenberger. "The Future of the European Electricity Grid Is Bright: Cost Minimizing Optimization Shows Solar with Storage as Dominant Technologies to Meet European Emissions Targets to 2050." *Energies* 10.12 (2017): 2080.
- Dreos, Ambra, Karl Börjesson, Zhihang Wang, Anna Roffey, Zack Norwood, Duncan Kushnir, Kasper Moth-Poulsen. "Exploring the potential of a hybrid device combining solar water heating and molecular solar thermal energy storage." *Energy & Environmental Science* 10.3 (2017): 728-734.
- Norwood, Zack, Ingo Theoboldt, and Dan-Eric Archer. "Step-by-step deep retrofit and building integrated façade/roof on a 'million program' house", *Conference proceedings of the 20th annual passive house conference*. Darmstadt, Germany, 2016.
- Norwood, Zack, Emil Nyholm, Todd Otanicar, and Filip Johnsson. "A geospatial comparison of distributed solar heat and power in Europe and the US." *PloS one* 9.12 (2014): e112442.
- Norwood, Zack, Daniel Kammen, and Robert Dibble. "Testing of the Katnix rotary lobe expander for distributed concentrating solar combined heat and power systems." *Energy*

Science & Engineering 2.2 (2014): 61-76.

- Carlson, Ola, Linus Hammar, Zack Norwood, and Emil Nyholm. "Harnessing energy flows: technologies for renewable power production." Chalmers University, *Systems Perspectives on Renewable Power* (2014): 32-45.
- Norwood, Zack, and Daniel Kammen. "Life cycle analysis of distributed concentrating solar combined heat and power: economics, global warming potential and water." *Environmental Research Letters* 7.4 (2012): 044016.
- Norwood, Zack, and Daniel Kammen. "Life cycle analysis: Economics, global warming potential, and water for distributed concentrating solar combined heat and power." *World Renewable Energy Forum, WREF, Including World Renewable Energy Congress XII and Colorado Renewable Energy Society (CRES) Annual Conference*, Denver, CO, United States, 2012.

Selected publications up to and including PhD dissertation

- Norwood, Zachary M. "A Better Steam Engine: Designing a Distributed Concentrating Solar Combined Heat and Power System", University of California, Berkeley, 2011, <https://search.proquest.com/docview/893628280>.
- Norwood, Zack, et al. "Assessment of combined heat and power system 'premium power' applications in California." *International Journal of Distributed Energy Resources* 6.2 (2010): 19.
- Sunter, Deborah A., Van P. Carey, and Zack Norwood. "Radial inflow turbine assessment for small-scale concentrated solar Rankine combined heat and power technology." *ASME Conference Proceedings*. Vol. 4556, 2010.
- Norwood, Zack, et al. "Performance-cost analysis of solar combined heat and power systems." *ASME Conference Proceedings*. Vol. 43956, 2010.
- Romanin, Vince, Van P. Carey, and Zack Norwood. "Strategies for performance enhancement of Tesla turbines for combined heat and power applications." Paper no. ES2010-90251, *ASME Energy and Sustainability Conference Proceedings*. Vol. 2. No. 43956, 2010.

Full list of publications on Google Scholar:

<https://scholar.google.se/citations?hl=en&user=XrDActAAAAAJ>

PEDAGOGICAL MERITS

Pedagogical coursework completed

- Göteborgs Universitet, HPE101 - Teaching and Learning in Higher Education 1 (5 credits)
- Göteborgs Universitet, HPE201 - Supervision in Postgraduate Programmes (5 credits)
- Chalmers Tekniska Högskola, CIU930 - Supervision of Research (3 credits)

Teaching

- 2017-2020, Khf Stacken, Development of a field trip (1.5 seminar and tour) of the Khf Stacken building passive house case study for a variety of university classes (e.g. Högskolan Dalarna, Chalmers Tekniska Högskola, and Göteborgs Universitet) and governmental and private organizations (e.g. Länsstyrelsen, Naturskyddsföreningen, Västra Götalandsregionen). Performed approximately 20 times from 2017-2020.
- 2019, Göteborgs Universitet, Responsible for development and presentation of a course module (1 hour seminar) on the challenge of achieving energy goals in the existing building sector for the master's level course GE6000 - Urban Climate and Urban Climate Planning.
- 2017-2019, Passive House Days, Open house (1.5 seminar and tour) of the Khf Stacken building passive house case study presented for the general public. Performed three times from 2017 to 2019.
- 2018-2019, Göteborgs Universitet, Responsible for development and presentation of a course module (2 hour lecture and seminar in both fall 2018 and 2019 semesters) on geographical information systems in energy system design and planning for the bachelor's level course GVN340 - Applied Climatology.
- 2015, Chalmers Tekniska Högskola, Co-responsible for development and presentation of a course module (3 hour lecture and seminar) focusing on solar power and intermittent renewables for the master's level course MEN115 - Energy systems modelling and planning.
- 2014, Chalmers Tekniska Högskola, Responsible for development and presentation of a course module (1.5 hour lecture) on solar power for the master's level course MEN115 - Energy systems modelling and planning.

Supervision

- 2018, Chalmers Tekniska Högskola, Master student co-supervisor for Evelin Blom "Analysis of policies and investments in local energy systems - Case study of Chalmers campus Johanneberg".
- 2017, Chalmers Tekniska Högskola, Master student co-supervisor for Somadutta Sahoo

“Evaluation of the benefits and investment strategies of the integrated heating-and-electrical supply systems: The case of Chalmers campus”.

- 2008-2011, University of California Berkeley, Supervised work of 4 graduate students, 5 undergraduate students, a project assistant, and a summer intern as project manager of the Distributed Concentrating Solar Combined Heat and Power project at the Renewable and Appropriate Energy Laboratory.

PROFESSIONAL ACTIVITIES, OUTREACH, AND OTHER

Selected invited speaker and referee assignments

- 2018-present, Invited referee for the MDPI open access journal Energies.
- 2019-09-20, “Kollektivhuset Stacken, ett pilotprojekt från miljonprogram till passivhus” Socialt Byggande och Modernt Självbyggeri Konferens. Göteborg, Sverige.
- 2019, Invited by Länsstyrelsen Kalmar to present the passive house renovation project Khf Stacken at Kalmarsundsveckan. Kalmar, Sverige.
- 2019-10-25, “Energy and indoor environment of Khf Stacken after passive house renovation with BIPV” Passivhus- och hållbarhets-konferensen. Laholm, Sverige.
- 2017-10-07, “Zack Norwood - Passivhusrenovering är lönsam”. Passivhuskonferensen, Intressegrupp Passivhus. Conference. Knivsta, Sverige.
- 2016-11-09, “Renoveringsrevolution av Flerbostadshus, Exempel 1: Kollektivhuset Stacken, Göteborg”. Sweden Green Building Council. BuildUpon workshop. Malmö, Sverige.
<http://buildupon.eu/wp-content/uploads/2015/09/Workshoprapport-2.pdf>

Selected appearances in popular media

- 2020-03-23, Svensk Ventilation, “FTX ventilation sparar energi”.
<http://www.svenskventilation.se/2020/03/ftx-ventilation-sparar-energi/>
- 2020-02-06, Aspegren, Anna-Klara publicerad på Renoveringsinfo.se, 2016 / Engstedt, Marit G. “Stacken gick från energislukare till passivhus”. Informationscentrum för Hållbart Byggande. <https://www.ichb.se/innehall/artiklar/stacken-gick-fran-energislukare-till-passivhus/>
- 2019-04-17 Wideberg, Lina, Anneli Wallander, Maria Thalwitzer “Solcells Rapport: 10 solcellsanläggningar i Sverige har följts upp och dokumenterats”. Offentliga Fastigheter. <http://offentligafastigheter.se/download/18.447c02bc16a7743570a6eec2/1557128835690/190417%20Solcellsrapport%20hela.pdf>
- 2018-12-14, Engelbrektson, Lotta. “Nya fasaden producerar nästan hela husets elbehov”. Glasbransch Föreningen.
<https://www.gbf.se/nyheter/nya-fasaden-producerar-nastan-hela-husets-elbehov>
- 2018-11-12, Munteanu, Jazz, “Miljonprogramhuset som ställt om”. SVT nyheter.
<https://www.svt.se/nyheter/lokalt/vast/miljonprogramhuset-som-stallt-om>
- 2018-04-24 Ohlson, Johanna, “Här fixar hyresgästerna egen el”. Hem & Hyra.
<https://www.hemhyra.se/nyheter/har-fixar-hyresgasterna-egen-el/>
- 2017-11-22, Gabrielson, Josefin, “Trenden: Välja passivhus”, GöteborgDirekt.
<http://www.goteborgdirekt.se/nyheter/trenden-valja-passivhus/repqkplzUA7W0Lqwzi4IS3oW Hs1Ew/>
- 2017-09-27, Åslund, Maria. “Miljonprogram blir passivhus”, Energi & Miljö.
<http://www.energi-miljo.se/tidningen/digitala-utgavor-av-energi-miljo/miljonprogram-blir-passivhus>
- 2017-08-27, Sistik, Hanna. “Välkommen till det första kollektiva passivhuset”, ETC Göteborg. <https://goteborg.etc.se/nyheter/valkommen-till-det-forsta-kollektiva-passivhuset>
- 2017-05-10, Andersson, Per. “Kollektivet som gör sin egen el”, Sveriges Natur.
<http://www.sverigesnatur.org/aktuellt/kollektivet-som-gor-sin-egen-el/>
- 2017-04-27 Moran, Annelie. “Miljonprogramshus blir passivhus”, Dagens ETC.
- 2016-09-22 Störner, Torgil. “Our campus - Our test arena”, Chalmers University.
<https://www.youtube.com/watch?v=vRHawSfiTfE>

Honours and awards

- 2008, \$500 2nd place award in poster competition received from the UC Berkeley Energy Symposium, University of California, Berkeley, USA
- 2006, \$5000 1st place award for Bears Breaking Boundaries Green Cities contest received from University of California, Berkeley, USA

Other interests

- 2015-present, Founding board member (CFO, Chairman) of Kooperativet Olgas Katter, a housing cooperative focused on a shared vegan and organic food system, Göteborg, Sverige.
- 2011, Completed an 8-month, 10 000 km solo bicycle trek around Cuba and from Sverige to Falastine.