PIRE Project

Bringing Societal Perspective into Multidisciplinary Design Thinking and Practice

David Hess, Professor, Sociology, Vanderbilt

Dasom Lee, Assistant Professor, Department of Technology and Governance for Sustainability, University of Twente

NSF Proposal: Goals

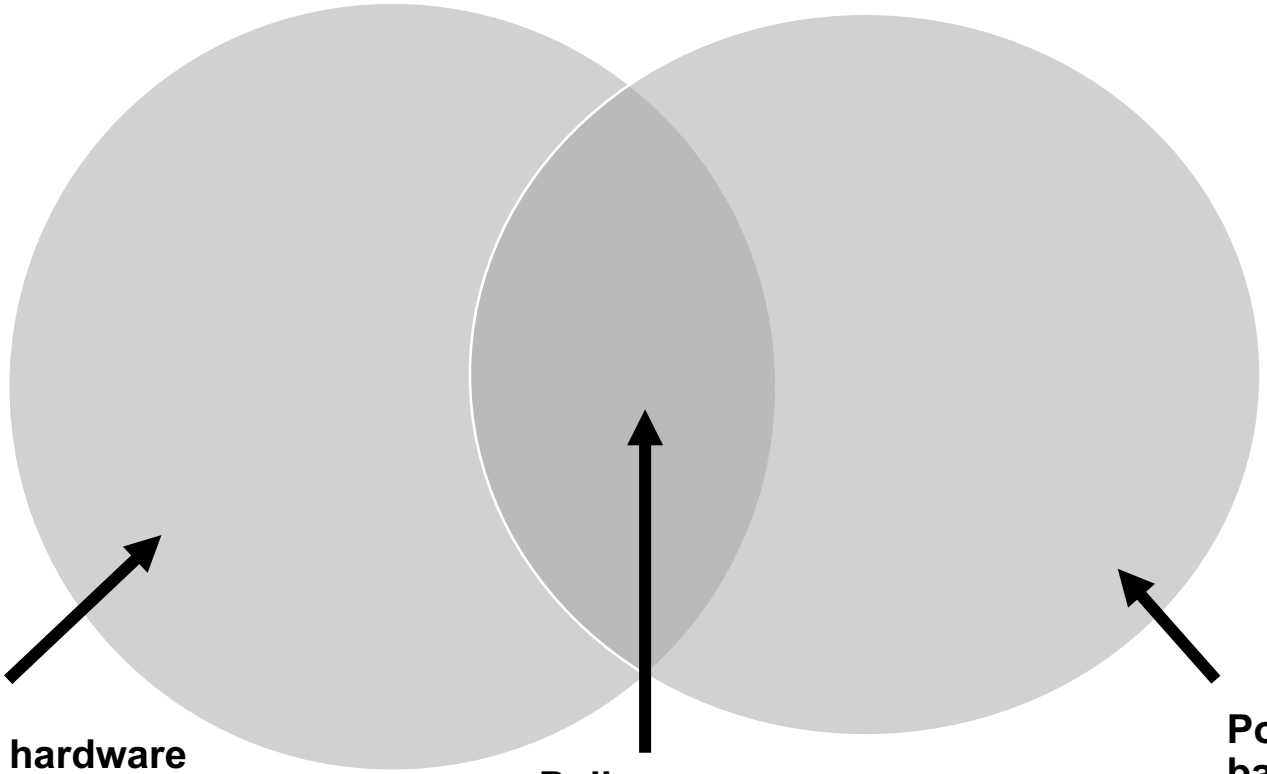
- "Understanding the nature, scope, and evolution of policies and societal expectations in the operation of societal-scale H-CPS in the US and in Europe as well as their comparative analysis."
- "Investigating methods for the explicit and formal representation of societal …. In this context, policies are on the one hand, expressions of societal expectations, and on the other hand formal, machine interpretable constructs that have potentially deep impact on the structure and operation of H-CPS."
  - Implication: design perspective

How to Implement?

Approach (Part 1): Design Orientation

“Policy-aware technology design and technology-aware policy design”

“Design” as a basis for interdisciplinary communication and cooperation



Software & hardware design based on technical values (functionality, elegance, simplicity efficiency, cost effectiveness)

Policy-aware technical design and technology-aware policy design

Policy design based on societal values (safety, security, equity, privacy, etc.)

Sources of orientation

- “Product Design in Innovation,” NSF (multidisciplinary design curriculum, RPI)
  - Interdisciplinary design with social scientists and engineers
- Sociotechnical integration research in the environment at Vanderbilt: ““Water Conservation and Hydrological Transitions in American Cities,” Hydrologic Sciences, NSF
  - Interdisciplinary research with social scientists and earth and environmental scientists
- Agile software development (Pretschner)

Approach (Part 2): Comparative Orientation

- Across values and policy domains
- Across countries and jurisdictions
- Across technological systems (CAVs, digital demand management, UAVs)

Approach (Part 2): Comparative Orientation

- Why comparative?
  - Global industries and standards
  - Multiple perspectives on a topic → innovation
  - Inclusion of societal perspectives (responsible research)

Approach (Part 2)

Comparative Perspective and “responsible research and innovation” tradition:

U.S. tradition:

Technology assessment (OTA)

→ELSI (ethical, legal, and societal implications)

→Sociotechnical integration research & STS (NSF)

European tradition:

Constructive technology assessment (Twente)

Participatory assessment

→ Responsible research and innovation

Collaborative PIRE Paper

David J. Hess (VU), Dasom Lee (VU), Bianca Biebl (TUM), Martin Fränzle (Oldenburg), Sebastian Lehnhoff (Oldenburg), Himanshu Neema (VU), Jürgen Niehaus (Oldenburg), Alexander Pretschner (TUM), and Janos Sztipanovits (VU)

A Sociotechnical Design Perspective on Responsible Innovation: Perspectives on Problem Finding for Multidisciplinary Research on Digitized Energy and Automated Vehicles. *Journal of Responsible Innovation*.

Sites of Implementation

Classroom training

Student projects

Workshops

Integration research

Social science research

Student Seminar

Societal Values	Connected Vehicles: Automated Vehicles and Ridesourcing	Automated Metering Infrastructure (AMI)	Unmanned aerial vehicles (UAVs, drones)
Privacy	Week 1 & 2 (Hess, Lee, and Sztipanovits)	Week 1 & 2 (Hess, Lee, and Sztipanovits)	Week 8
Safety	Weeks 3, 4, 5 (Hess, Work, Karsai)	Weeks 3, 4, 5 (Hess, Work, Karsai)	Week 8
Security	Week 6 (Koutsoukos)		Week 8
Sustainability	Week 7 (McKane)	Weeks 9, 10 (Hess, Neema)	Week 8
Equity	Week 7 (McKane)	Weeks 8, 9, 10 (Hess, Neema)	Week 8
Democracy (Governance)	Week 1 (review article) Week 3 (civil society and CAVs)	Week 1 (review article)	Week 8

Student Summer Projects

Not all projects had sociotechnical integration, but some did.

Examples:

Security: develop algorithms for assessing security risk and threats to digital electricity systems

Safety: translate consumer and public demands for safety into an approach to reducing the risk of collisions in CAVs

Safety, sustainability: model system structures that tilted agent-based decisions either toward individual driver benefits or toward system-level traffic benefits of congestion reduction

Workshops

Sessions with presentations from German and US researchers

Includes social scientists and government officials on societal and policy dimensions

Integration Research

Partnership of computer science and social science faculty and students. Cross training of students. GridLAB-D

Lee, Dasom, David J. Hess, and Himanshu Neema. 2020. The Challenges of Implementing Transactive Energy: A Comparative Analysis of Experimental Projects. *The Electricity Journal* 33(10): 106865.

Neema, H., Sztipanovits, J., Hess, D.J. and Lee, D., 2020, April. TE-SAT: Transactive Energy Simulation and Analysis Toolsuite. *2020 IEEE Workshop on Design Automation for CPS and IoT (DESTION)*. Sydney, Australia: pp. 19-20. IEEE. 10.1109/DESTION50928.2020.00009.

Himanshu Neema, Scott Phillips, Dasom Lee, David J. Hess, Zachariah Threet, Thomas Roth, and Cuong Nguyen. 2021. Transactive Energy and Solarization: Assessing the Potential for Demand Curve Management and Cost Savings. In DESTION ’21: Design Automation for CPS and IoT, May 18, 2021, (Virtual). ACM, New York, NY, USA, 7 pages. https://doi.org/m.n.o.

Transactive Energy and Solarization: Assessing the Potential for Demand Curve Management and Cost Savings

Himanshu Neema
himanshu.neema@vanderbilt.edu
Vanderbilt University
Nashville, TN, USA

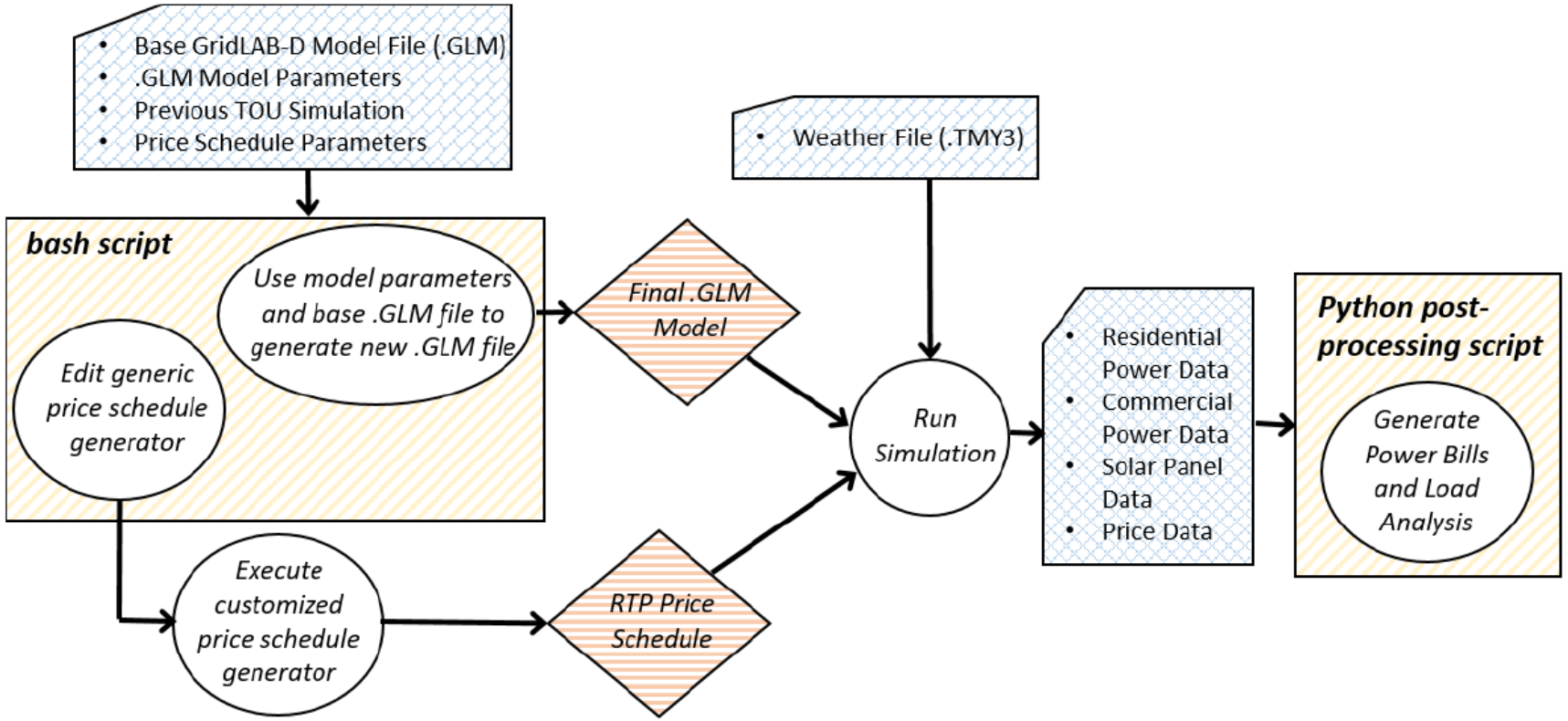
Scott Phillips
Vanderbilt University
Nashville, TN, USA

Dasom Lee
University of Twente
Enschede, Netherlands

David J. Hess
Vanderbilt University
Nashville, TN, USA

Zachariah Threet
Tennessee Technological University
Cookeville, TN, USA

Thomas Roth
Cuong Nguyen
National Institute of
Standards & Technology



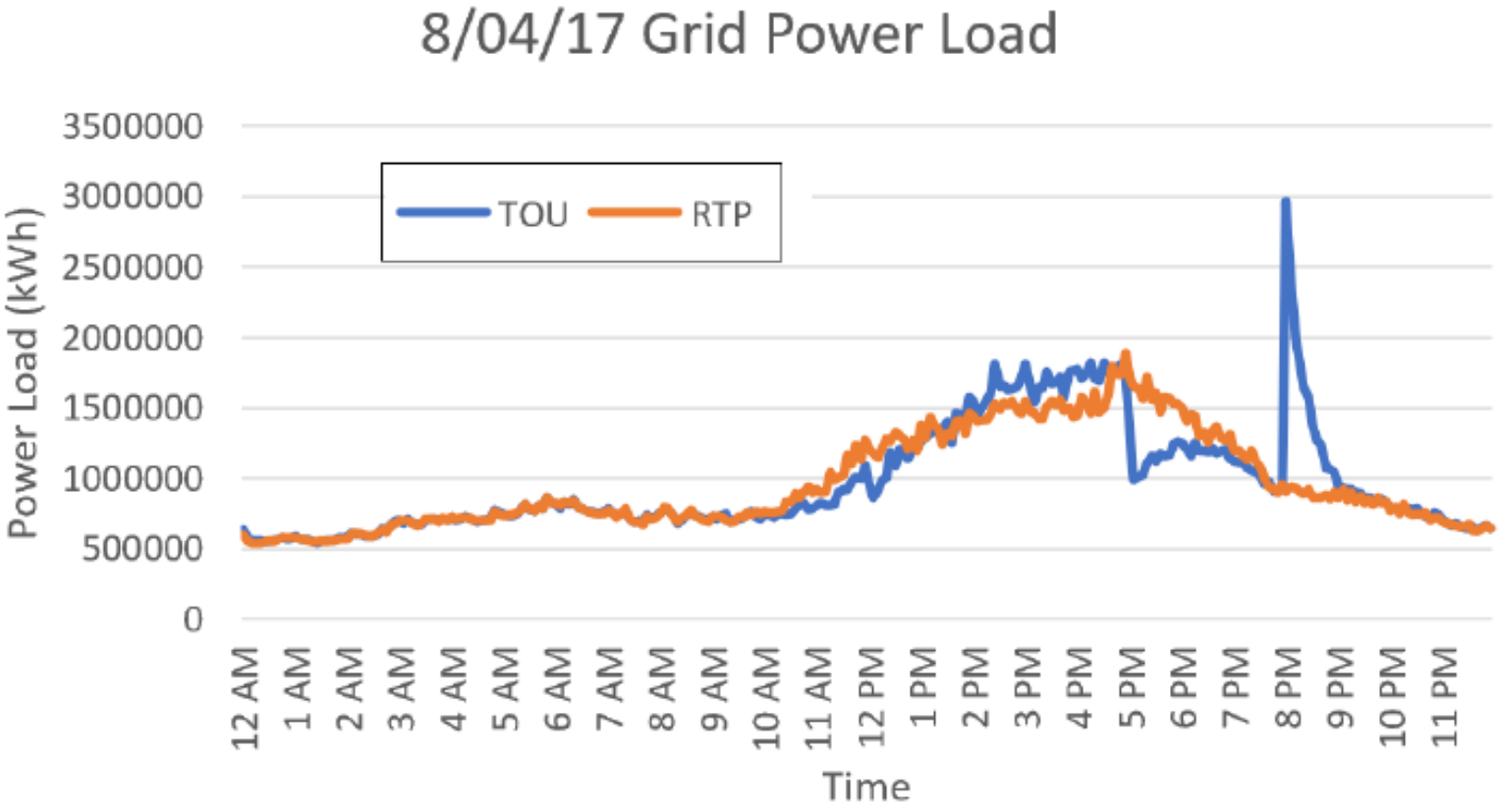


Figure 3: TOU vs RTP Comparison

Social Science and Policy Research

Invited lectures

2021 Transition challenges for transportation systems: A survey on sustainability and equity of rideshare services and public transportation. International Sustainability Transitions conference. Karhlsruhe, **Germany**.

2021 "IPU Policy Forum: Can We Utilize Smart Meter Data and Maintain Consumer Privacy?" Dasom Lee and David Hess, Institute of Public Utilities, Michigan State University, May (NSF PIRE grant).

2020 "Safety and Equity Issues in Connected and Automated Vehicles." David Hess, Dasom Lee, Rachel McKane. Invited presentation, **Technical University of Munich**, December. (NSF PIRE grant.)

2020 "Assessing Societal Concerns of Automated Vehicles: Policy and Design Implications." David Hess, Dasom Lee, and Rachel McKane. UCLA, Institute for Pure and Applied Mathematics, Workshop IV: Social Dynamics beyond Vehicle Autonomy, December. (NSF PIRE grant.)

Publications: Comparative Policy

Under Review. Dasom Lee and David J. Hess. Public Opinion on Connected and Automated Vehicles: Focusing on CAV Interests, Safety, Privacy, and Security. *Humanities and Social Science Research*, special issue on CAVs and society.

Under review. Dasom Lee, David J. Hess, and Michiel A. Heldeweg. Safety and Privacy Regulations for UAVs: A Multiple Comparative Analysis. *Technology in Society*.

2021. Hess, David J. Undone Science and Smart Cities: Civil Society Perspectives on Risk and Emerging Technologies. Johannes Glückler, Heinz-Dieter Meyer, Laura Suarsana (eds) *Knowledge and Civil Society (Knowledge and Space, Vol 17)*. Cham: Springer International.

2021. Lee, Dasom, and David J. Hess. Privacy and Smart Meters in Residential Buildings: A Comparative Analysis and Assessment of Harmonization Potential. *Utilities Policy* 70: 101188.

2020. Dasom Lee and David Hess. Regulations for On-Road Testing of Connected and Automated Vehicles: Assessing the Potential for Global Safety Harmonization. *Transportation Research A: Policy and Planning* 136:85-98. (June) doi.org/10.1016/j.tra.2020.03.026

2020. David Hess. Incumbent-led transitions and civil society: future autonomous vehicle policy and consumer organizations in the United States. *Technological Forecasting and Social Change* 151: 119825.

Postdoctoral Training

Rachel McKane (now at Brown University)

Use of existing research and data on ride-sharing to identify potential future equity policy issues for CAVs.

Rachel G. McKane and David J. Hess. The Impact of Ridesourcing on Equity and Sustainability in North American. Cities: A Systematic Review of the Literature. *Cities*.

Rachel G. McKane and David J. Hess. Ridesourcing and Urban Inequality in Chicago: Connecting Mobility Disparities to Unequality. *Environment and Planning A*.

Related Research: Digital Transitions and Local Energy

Ryan T. Trahan and David J. Hess:

2021. Who Controls Electricity Transitions? Digitization, Decarbonization, and Local Power Organizations. *Energy Research and Social Science*.

In progress. Survey of local power organizations in the TVA region to examine digitization and distributed energy transitions.

International Collaborations

Germany:

- Oldenburg: Mark Schweder, Markus Tepe, Jürgen Tager (proposed German counterpart project)
- TUM: Bianca Biebl (RRI paper)
- Bast: Tom Gasser (German law on CAVs)
- Heidelberg: Johannes Glückler (paper on digitization & smart cities)
- Stuttgart: Gregor Kungl (related project on energy transitions)
- Technical University Berlin: Tobias Biehle (drones—presented at workshop on same panel)

Other European Countries:

- Twente: Michiel A. Heldeweg (drones paper)
- University College London: Jack Stilgoe (special issue on CAVs)
- U. Padua, French National Centre for Scientific Research: Various people; workshop on smart meters and public acceptance

Related International Collaboration (Comparative, Sociotechnical Perspective)

2020. Sociotechnical Agendas: Reviewing Future Directions for Energy and Climate Research. *Energy Research and Social Science* 70: 101617.

Eighth most highly cited paper in 2020 in high-ranking energy journal.

Benjamin Sovacool (Sussex, UK), David Hess (VU), Sulfikar Amir (Nanyang Tech U), Frank Geels (Manchester, UK), Richard Hirsh (Virginia Tech), Leandro Rodriguez Medina (U Americas, Mexico), Clark Miller (Arizona State), Carla Alvial Palavicino (Utrecht), Roopali Phadke (Macalaster), Marianne Ryghaug (Norwegian U of S&T), Johan Schot (Sussex), Antti Silvast, Jennie Stephens (Northeastern), Andy Stirling (Sussex), Bruno Turnheim (France), Erik van der Vleuten (Eindhoven), Harro van Lente (Maastricht), Steven Yearley (Edinburgh).