

SMART ISLAND ENERGY TRANSITION: ASSESSING HAWAII'S MULTI-LEVEL, POLICY- DRIVEN APPROACH

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ABSTRACT

Islands share the common characteristic of having **isolated energy systems** and a historical **reliance on energy imports**, predominantly fossil fuels, for their electricity and transportation needs. Such reliance on imported fossil fuels has not come without significant economic and environmental consequences and difficulties. The urgency to address **climate change, energy security and reliability, and price volatility are the stimulus** for rapid and transformational socio-technical changes. This study offers insight on Hawaii's policy and deployment progress in transitioning its island energy system. By applying **sustainable transition management and niche-level innovation theories**, we conceptualize **island energy transition as a multilevel and purposive policy-driven sustainability and self-sufficiency socio-technical intervention using available renewable energy sources, improved and smart grids, and efficient energy storage and consumption**. To apply this analytic framework, this study examines the governance model in Hawaii employed from the inception of **the Hawaii Clean Energy Initiative**, a comprehensive island energy transition, to the present day. Based on document analysis, and in-depth interviews with energy stakeholders, we assess progress on Hawaii's energy system transformation and subsequent socio-technical innovation as it develops the long-term pathway to achieve its ambitious energy policy objectives. In particular, we probe into the source and level of change, and how policies have stimulated actions at the niche level to overcome significant policy and technological hurdles and achieve record levels of indigenous distributed energy resources in the electricity sector. This research contributes to energy policy literature by providing (1) **a conceptual framework of island energy transition**; (2) **a review of policy and technology solutions at the local level to support change**; (3) a case study of a first-of-its kind demonstration project between Japan and the State of Hawaii; and (4) policy implications for other countries' island energy transition efforts.

HIGHLIGHTS AND KEYWORDS

Islands are catalyzed by climate change and reliance on fossil fuels to transform energy system.

Island energy transition consists of renewable energy, smart grid, energy storage & governance.

Niche level socio-technical innovation leads to island energy transition.

Keywords: Island energy transition; renewable energy system; smart grid; energy governance; socio-technical change

AIMS

To examine motivation, process, and outcome of island energy transition using system transition theory as analytic framework.

To conceptualize the island energy transition and to classify the components of the concept (module)

To identify the technological and policy innovation in island energy transition.

RESEARCH QUESTIONS

What consists of energy transition in islands?

Why do we need island energy transition (IET) ?

What drive IET at landscape, regime and niche levels?

How do we accomplish IET and what are barriers?

LITERATURE REVIEW

Renewable energy supply for island (Chen et al. 2007; Duic et al. 2008; Katsaprakakis et al., 2009; Ma et al. 2013; Sanseverino et al. 2014; Senju et al., 2007)

Smart grids in islands (Mah et al. 2012)

EV in island (Pina et al. 2014)

Lack comprehensive model/definition for smart island energy transition

WHY ISLANDS AND ISLAND ENERGY TRANSITION?

High prices and dependence of imported energy

Abundant renewable resources (wind and solar)

Energy security: 3 weeks of stored energy 2 weeks for food (hurricanes etc. DBEDT 2015, p. 36)

Geographical benefits (proximity) for EV operation

decentralized (isolated) energy system: scale up and diffusion innovation and experimentation

Oil spill and fossil fuel burning: tourism and fishing industry

Carbon reduction

DEFINITION OF ISLAND ENERGY TRANSITION

a multilevel and purposive intervention for the island energy system to adopt available and existing renewable energy sources, smart grid systems and electricity storage including vehicle to grid technologies with cooperative governance between the public and private sectors.

Aims to provide and consume self-sufficient, affordable, stable, and sustainable, and secured energy.

Island energy transition as a system rather than renewable energy sources

SYSTEM TRANSITION THEORY

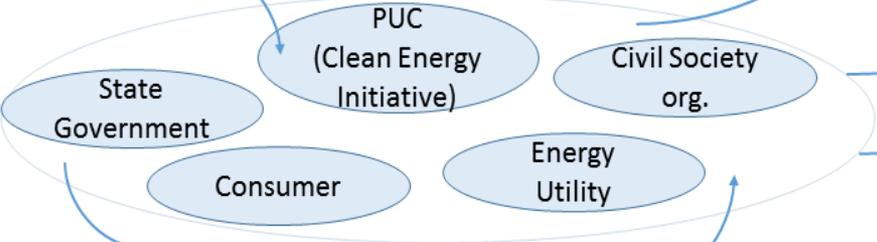
Landscape :

Global & Federal Trends



Regime :

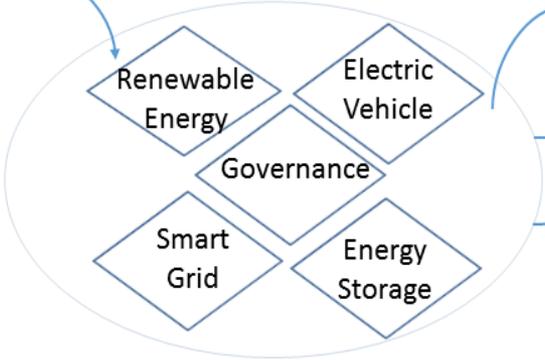
Hawaii State



Sustainability

Niche :

Jump Smart Maui Project



COMPONENTS OF ISLAND ENERGY TRANSITION

Renewable Energy Supply	<ul style="list-style-type: none">-the assessment of existing energy (and electricity) supply system-mapping & efficiently procuring available renewable energy resources and technologies-social and economic adoption of renewable energy resources
Grid Improvements and the Smart Grid	<ul style="list-style-type: none">- the evaluation of smart grid technology innovation-drivers and obstacles to smart grid adoption (cost, benefits, knowledge, and institution) [32]-the roles of governments, utilities, communities, businesses in island smart grid adoption
Electricity Storage System	<ul style="list-style-type: none">-identifying available energy system (reversible hydro, hydrogen, fixed batteries, electric vehicles)-social, economic, and technical assessment of power storage options
Governance	<ul style="list-style-type: none">-Identifying stakeholders-Setting the energy transition goal & accountability on progress towards that goal-Process of decision making in renewable energy supply, smart grid, and power storage system planning and RD&D-Experimentation, participation and education

LANDSCAPE LEVEL

Obama's Climate Action Plan (2013) & Executive Orders: Renewable Energy Adoption+Grid+Transport

American Recovery and Reinvestment Acts (2009) and Renewable Energy

Paris Agreement 2015 (INDC): GHG reduction and renewable energy adoption

Investment & tax credit for renewable energy

REGIME TRANSITION

Hawaii Clean Energy Initiative (2008) + USDOE

100% renewable RPS by 2045 (2015)+Act 100 (2015)+State's technical assistant

High cost of electricity (1.5-2 times of US)

Geographic benefits (abundant solar, wind + limited mileage for EVs)

Hawaii –NEDO of Japan Cooperation

NICHE LEVEL

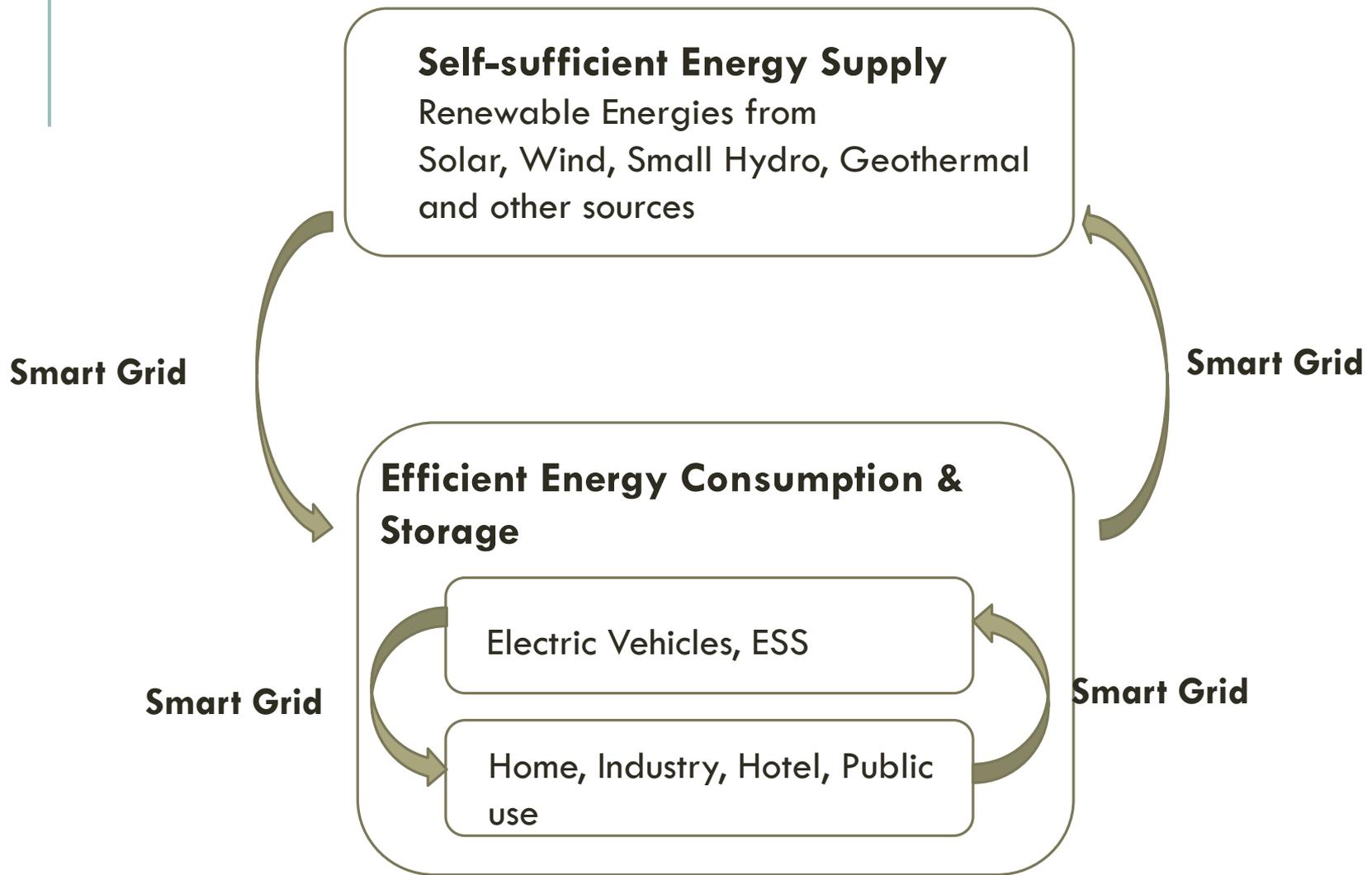


Figure. Conceptualizing Island Energy Transition

GOVERNANCE

Public

State

County (Mayor office and council)

NPO

Research: HNEI, Univ of Hawaii

Hitachi, Nissan, NEDO

Hawaii State's laws for energy transition

Year	Bill Number	Details
2017	HB1170 (Act 220)	Adds producers that use <u>geothermal resources</u> to produce electrical or thermal energy to the definition of renewable energy producers that may lease public lands without public auction
	HB2416 (Act 027)	Repealed 201N, relating to the Renewable Energy Facility Siting Process (REFSP). Despite the efforts of Hawaii State Energy Office, the REFSP was never implemented since it was introduced in 2008.
	HB2569 (Act 176)	Requires the department of education to establish a goal of becoming net-zero with respect to energy use in all public school facilities
	SB2652 (Act 202)	Establishes a 5-year renewable fuels production tax credit program
2018	HB1508 (Act 121)	Creates a revolving line of credit sub-fund within the Hawaii green infrastructure special fund for a state agency to finance cost-effective energy-efficiency measures
	HB2075 (Act 067)	Reestablished a matching grant pilot program to support Hawaii's local companies that conduct renewable energy research and development (the original program was established in 2015 and expired June 2017)
	HB1986 (Act 016)	Reaffirms that Hawaii's natural environment is threatened by global climate change and requires the Office of Planning in partnership with the Greenhouse Gas Sequestration Task Force to establish a framework for a carbon offset program
	SB2939 (Act 005)	Requires the PUC to establish performance incentive and penalty mechanisms that directly tie electric utility revenues to the utility's achievement on performance metrics on or before January 1, 2020

BARRIERS

Adopting innovation (hesitance)

Misperception (solar, smart metering, EV)

Penetration of outside ideas

Trust (utility, auto-dealership)

Economic barriers (investment)

Tech barriers + siting

DISCUSSION & CONCLUSION

Holistic approach for energy eco-system

Multilevel (Landscape, regime) supports for niche level transition: Tax Credit from Federal gov. and RPS from State Gov.

Supporting/Coordinating Org. Jump Smart Maui

Incentives and education for change behavior