Development of the Taiwan city index: localizing metrics to evaluate cities in Taiwan

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Abstract

Local governments throughout the world can take action to lead on energy efficiency. Those that do make their communities better, stronger, and more resilient. Comparing the efficiency initiatives of different local governments can help identify those who are leading on energy efficiency and those with room to do more. This benchmarking process also uncovers best practices in policy development and implementation, as well as general lessons learned.

This paper describes a collaboration between partners in the United States and Taiwan to create a set of metrics to evaluate the efficiency efforts of Taiwanese cities. Previously, the US partner developed a comprehensive methodology to benchmark the efficiency activities of local governments in the United States. The *ACEEE City Energy Efficiency Scorecard* is a biennial benchmarking effort that captures trends in local policy development in the US and provides actionable guidance for local governments seeking to prioritize efficiency. Just as this city benchmarking has been valuable for US cities, a similar initiative for Taiwanese cities can yield similar benefits.

This research captures the procedures used to localize the US metrics to the Taiwanese context and develop the *Taiwan City Energy Efficiency Index*. It discusses the research findings that affected our decisions to adjust the methodology and metrics. We discuss differences in the electric utility landscape, local government capacity to act, and efficiency policies. We explain how energy-efficiency metrics can be localized to fit different local contexts. By outlining the process of localizing metrics, this paper serves as guidance for others considering methods of locally benchmarking energy efficiency efforts across all energy sectors.

Introduction

Urbanization is accelerating around the globe, with the number of people living in cities expected to double by 2050, especially in Asian countries (Siemens 2011). Two-thirds of energy consumption across the globe happens in cities, which accounts for three-fourths of global greenhouse gas (GHG) emissions (Bose 2010; UNEP 2015). By investing in energy efficiency policies, cities can help curb energy demand and GHG emissions in the coming decades. Wasting less energy can also be a strategy for reducing local pollutants, an issue of particular importance in Taiwan. The PM_{10} concentrations in the cities assessed in the *Taiwan City Energy Efficiency Index* all exceed the World Health Organization's recommended thresholds (WHO 2016).

The American Council for an Energy-Efficient Economy (ACEEE) and the Industrial Technology Research Institute of Taiwan (ITRI) partnered on a project to evaluate energy efficiency practices in Taiwanese cities. This project aimed to localize ACEEE's *City Scorecard* methodology to the Taiwanese context. The *City Scorecard* is a biennial report currently in its third iteration which evaluates 51 large US cities on energy efficiency policies in five categories: local government operations, community-wide initiatives, energy and water utilities, transportation policies, and building policies (Ribeiro et al. 2017). By focusing on this wide-range of policy categories, the *City Scorecard* acts as a best practice road map cities can fol-

low to both learn from peer cities as well as strive for the most progressive efficiency policies. The end result of the collaboration described below is another research report, the *Taiwan City Energy Efficiency Index*, which serves the same purpose for Taiwanese cities. In order to improve local energy efficiency policies, cities first need to evaluate the policies they already have in place.

Goal of the Taiwan city energy efficiency index

ACEEE and ITRI began their partnership in the fall of 2015. ACEEE served as the expert in local energy efficiency policy evaluation, due to experience evaluating US policies at the national, state, and local level. ITRI interfaced directly with local government staff in Taiwan and collected data. The first outcome of the collaboration was a memo that detailed the methodology that could be used to adapt the *City Energy Efficiency Scorecard* to the Taiwan context. We faced numerous challenges as we created the initial memo, such as lack of available local-level data on energy efficiency policies in Taiwan, differences in political structures at the local and state/provincial levels, and the applicability of US metrics in an international context. In 2016, ACEEE and ITRI followed up the 2015 memo by working together to create a report that evaluated the six special municipalities in Taiwan (i.e. Kaohsiung, New Taipei, Taichung, Tainan, Taipei, and Taoyuan).[1] See Table 1 for more information on these cities. This paper discusses the process of adapting this research from the US to Taiwan contexts, as well as the challenges and lessons learned during this endeavour.

The goal of the Taiwan City Index project was to adapt the US *City Scorecard* into a report relevant to Taiwanese cities, which could be used to inform the cities on the current state of their efficiency policies and ways they could move forward. This was the first time ACEEE localized the *City Scorecard*'s methodology into a non-US context. Others could use a similar process to develop scoring metrics for cities in different countries.

Best practice policy metrics and evaluation approaches

ACEEE and ITRI worked together to adapt the US scoring metrics to ones that were relevant for cities in Taiwan. The metrics quantitatively score cities based on qualitative policy information. For example, cities earn points if they have a policy that helps limit energy use (e.g. efficiency goals, efficient vehicle policies, building energy codes, etc.) By focusing on policy metrics, the report's findings are actionable and allow cities to better advance their energy efficiency policies. The *Index* is not meant to compare cities to one another, but to show areas for improvement in each city's individual policies.

Challenges to adapting the City Scorecard to Taiwan

While adapting the *City Scorecard* into the *Taiwan City Index*, we came across numerous differences between the policy landscape in the United States and Taiwan that made it necessary to change and adapt the metrics and overall methodology. The US version contains 5 policy areas with over 50 metrics. In the Taiwan version, we reduced the methodology to 4 policy areas – local government operations, community-wide initiatives, building policies, and transportation policies – with 17 individual metrics across the policy areas (see Table 2). We kept the metrics that were most applicable for Taiwanese cities and adapted them so they best fit the Taiwan context.

UTILITY-ADMINISTERED ENERGY EFFICIENCY PROGRAMS

Taiwan's electric utility, Taipower, offers few energy efficiency programs for residential, commercial, and industrial customers. This differs from utilities in the United States, who are the main providers of energy efficiency programs (Berg 2016). Because of this, we removed the fifth policy category that was included in the US version: energy and water utilities. We did keep metrics on energy and water efficiency programs at the city level in the community-wide section, as the cities run their own programs in line with city-specific energy or climate goals.

LOCAL GOVERNMENT CAPACITY TO ACT

Accounting for the ability of local governments to take control and act on efficiency policies is an important aspect of designing a local policy index. According to Hammer (2009), the capacity for local governments to act varies greatly across the globe, with climate change policy pushing many local governments to move forward with their own clean energy policies. The influence of US local governments over policymaking is different than that of Taiwanese local governments. Although the capacity for US cities to act on energy-efficiency and other policies varies amongst cities, they generally have more autonomy than cities in Taiwan to enact these policies. Some cities in the United States have the legislative authority to adopt building codes and enact energy benchmarking ordinances.[2] For cities served by municipally-owned energy or water utilities, local governments can directly influence utility policy. If a city is served by a private utility, the local government can partner with that utility to encourage stronger energy efficiency programs and actions.

In Taiwan, energy efficiency governance is regulated by the Energy Administration Act, which focuses on state-level governance with little focus on local governments. As a result, the local governments are not held responsible for energy efficiency policy and the majority of energy efficiency policies are initiated by the central government. However, the Act does not prohibit local governments from focusing on energy efficiency in their communities. For example, the Smart Energy Saving Program allowed cities in Taiwan to ramp up energy efficiency efforts at the local level, with funding and support from the central government. This program provides additional focus and resources to local governments to advance energy efficiency policies.

1. Special municipalities are the largest cities in Taiwan and sit directly under the jurisdiction of the central government. Smaller cities do not; they are subdivisions of provinces that sit under the central government's jurisdiction (ROC 2016).

2. For more information on US energy efficiency policies at the city level, see the 2017 ACEEE City Energy Efficiency Scorecard (Ribeiro et al. 2017).

Table 1. Key information for the assessed cities, i.e., "special municipalities".

City	Population	Number of households	City area (sq. km.)	Community-wide electricity use (GWh)
Kaohsiung	2,778,918	1,072,939	2,951.85	29,088
New Taipei	3,970,644	1,510,900	2,052.57	20,143
Taichung	2,744,445	927,901	2,214.90	25,886
Tainan	1,885,541	672,325	2,191.65	25,901
Taipei	2,704,810	1,043,948	271.80	16,175
Taoyuan	2,105,780	750,501	1,220.95	27,814

Source: DGBAS 2016. Note that the study focused on electricity and other energy sources. The data in this chart presents only part of the overall energy picture in Taiwanese cities.

BUILDING ENERGY CODES

For US cities, strengthening building energy codes proves to be an important tool for increasing energy efficiency in buildings. Many US cities can show leadership by adopting model energy codes that are updated every three years or by adopting codes that are more stringent than these model codes. For example, the city of Boston adopted the Massachusetts Stretch Energy codes, which go beyond the state-mandated energy codes. In Taiwan, the central government has the authority to establish and adopt energy codes for residential and commercial buildings. However, the national energy codes have not been updated in 20 years. Therefore, the building energy code metrics in the *Taiwan City Index* focus on rewarding local governments that require greater levels of efficiency than called for in the outdated central government codes.

COMPACT CITIES

In the United States, an important strategy to reduce energy waste in the transportation sector is to encourage the development of compact cities. However, Taiwan cities are not as sprawling as US cities, and many cities in Taiwan have already been significantly developed. As such, in the transportation policy section, we deemphasized metrics related to the compactness of cities and focused more on policies that increased multimodal access and efficient vehicles.

LACK OF ENERGY POTENTIAL STUDIES

The US *City Scorecard* uses energy-saving potential studies to help assign points to policy metrics and overall categories so that an overall score can be aggregated for each city based on all the policy categories. Due to a lack of available data on energy-saving potential in Taiwan, ACEEE and ITRI were not able to create a "scorecard-like" report that provided a final score for each city. Instead, each policy area should be examined independently to see how well each city is achieving best practices in each area.

Metrics and findings

After accounting for the challenges listed above, we were able to develop metrics for analysing the energy efficiency efforts of cities in Taiwan. We continued to use the US version as a guide as we identified the most relevant metrics and created new metrics that better fit the context of Taiwanese cities.

METRICS

The final methodology for the *Taiwan City Index* included four policy areas—local government operations, community-wide initiatives, building policies, and transportation policies. Each policy area contained 3 to 5 metrics, seen in Table 2. Each policy area should be seen as a separate index. These four indices are meant to be analysed separately to see how the city can advance policies in each respective policy area.

We determined the distribution of points among the policy areas in the *City Scorecard* based on studies of local energy savings opportunities, analyses of city energy consumption patterns, and expert judgements from ACEEE staff and other experts. For the *Taiwan City Index*, energy potential studies for Taiwan were scarce to non-existent, so we adapted the point allocations from the US version. We kept in mind the differences in political and energy landscapes as well as the input from experts on Taiwan energy policy.

Local government operations

The local government operations metrics focus on policies that affect the efficiency of local government services, such as education, healthcare, police, firefighters, public works, urban planning, parks and recreation and more. Local governments have the unique ability to lead by example and push forward on efficiency in their city. For scoring in this metric, we awarded 2 points towards local government energy efficiency goals, 5 points for procurement and construction policies, and 3 points for asset management policies.

Local government operations points were awarded as follows:

- *Local Efficiency Goals*: 1 point for having a local government efficiency goal in place, and up to 1 point for making progress on that goal.
- *Procurement and Construction Policies*: 1 point for fleet efficiency, 1 point for fleet right sizing, 1 point for efficient public lighting, 1 point for energy efficiency requirements for new public buildings, and 1 point for energy efficiency or life-cycle cost consideration in procurement policies.
- *Asset Management*: 1 point for public building benchmarking requirements, 1 point for public building retrofit strategies, and 1 point for sustainable infrastructure policies.

Table 2. Scoring by policy area and metric category.

Policy area and categories	Maximum score
Local government operations	10
Local government energy efficiency goals	2
Procurement and construction policies	5
Asset management	3
Community-wide initiatives	7
Community-wide energy efficiency goals	2
Efficient distributed energy systems	2
Urban heat island mitigation	1
Energy data access and use	1
Efficiency efforts in water services	1
Buildings policies	10
Local building energy ordinances	4
Building energy code compliance	1
Requirements and programs for efficient buildings	4
Benchmarking, rating and transparency policies	1
Transportation policies	10
Transportation planning strategies	1
Mode shift strategies	4
Availability of transportation data	2
Public transit policies	1
Efficient vehicle polices	2

Community-wide initiatives

These policies focus on energy efficiency throughout the community, focused on policies that the local governments can influence. These policies are wide-ranging from GHG goals to energy data access. In this section, we awarded 2 points for community-wide energy efficiency goals that go beyond government buildings and encompass the whole city, 2 points for efficient distributed energy systems, 1 point for policies that focus on urban heat island mitigation, 1 point for energy data access and use by the local government, and 1 point for efficiency efforts in water services.

Community-wide initiatives points were awarded as follows:

- *Community Efficiency Goals:* 1 point for having a community-wide goal in place and up to 1 point for progress towards that goal.
- *Efficient District Energy and Combined Heat and Power (CHP):* 1 point for CHP capacity and 1 point for planning for future CHP development.
- *Mitigation of Urban Heat Islands:* 1 point for policies to mitigate urban heat island effect.
- *Access to Energy Data:* 1 point for energy data used in planning processes.
- *Efficiency Efforts in Water Services:* 0,5 points for a water savings target and 0,5 points for water efficiency programs.

Building policies

Although the central government has most of the control over the stringency of building codes in Taiwan, there are policies cities can put in place to encourage more efficient building development. These metrics focus on privately owned buildings, both existing and new construction. In this section, we awarded 4 points for local building energy ordinances, with points awarded for policies affecting both residential and commercial buildings, and for green building certification requirements. We also awarded 1 point for building energy code compliance strategies. We allocated 4 points for requirements and programs for efficient buildings, such as energy efficiency programs targeting residential and commercial customers and energy audit, retrofit, or energy use reduction requirements. Finally, we awarded 1 point for benchmarking, rating, and transparency policies for residential and commercial buildings.

Buildings policy points were awarded as follows:

- *Local Building Energy Ordinances:* 1 point for adopting local energy ordinances for the residential sector and 1 point for the commercial sector.
- *Green Building Program Implementation:* 1 point for residential and 1 point for commercial green building requirements.
- *Building Energy Code Compliance:* 1 point for code compliance strategies (eg. required training on energy code plan review and inspection, up-front-support for code officials on compliance).

- *Building Energy Benchmarking and Transparency:* 1 point for mandatory benchmarking requirements for residential and commercial buildings (0,5 points for each).
- *Requirements and Programs for Efficient Buildings:* 1 point for energy audit, retrofit, or energy use reduction requirements for commercial buildings and 1 point for residential buildings, and 1 point for energy efficiency programs targeting residential customers and 1 point for programs targeting commercial customers.

Transportation policies

These policies focus on vehicle efficiency as well as the transportation system as a whole. We awarded 1 point for efficient transportation planning strategies, 4 points for mode shift strategies to encourage shifting from private to public transportation options, 2 points for the availability of transportation data for ICT services, 1 point for policies that encourage public transportation use, and 2 points for policies that encourage the purchase and use of efficient vehicles.

Transportation policy points were awarded as follows:

- *Mode Shift Strategies:* 1 point for travel modal targets, 1 point for a sustainable transportation plan, 1 point for car sharing, and 1 point for bike sharing.
- *Public Transit Policies:* 1 point for incentives for public transit use.
- *Planning for Transportation Efficiency:* 1 point for policies to encourage multimodal access.
- *Efficient Vehicles:* 1 point for purchase incentives for efficient vehicles, 1 point for incentives for electric vehicle charging infrastructure.
- *Open Data and Data Platforms:* 1 point for promoting open access to public bus service and 1 point for promoting open access to comprehensive transportation data.

SCORING

ACEEE and ITRI sent data requests to all of the cities in the study in order to obtain the necessary data to score them on each metric. We also held one-on-one meetings with interested cities and a seminar with experts from academia and nonprofits in Taiwan to discuss the development of the *Index* and its metrics. ACEEE assigned points to city efforts based on the assessment of information returned in the data requests as well as information that ITRI gathered independently. The results were also reviewed externally by cities and other stakeholders before publication to ensure cities were scored using accurate information. There are likely data gaps for the two cities who chose not to submit their completed data requests.

FINDINGS

The overall findings of the *Taiwan City Energy Efficiency Index* indicate that some cities in Taiwan have already begun taking steps to increase energy efficiency, but all still have opportunities to move forward with strong energy efficiency policies. Cities ranged widely in the number of points they earned in each policy area. Figure 1 displays the percentage of points earned by the six special municipalities in each policy area. The results

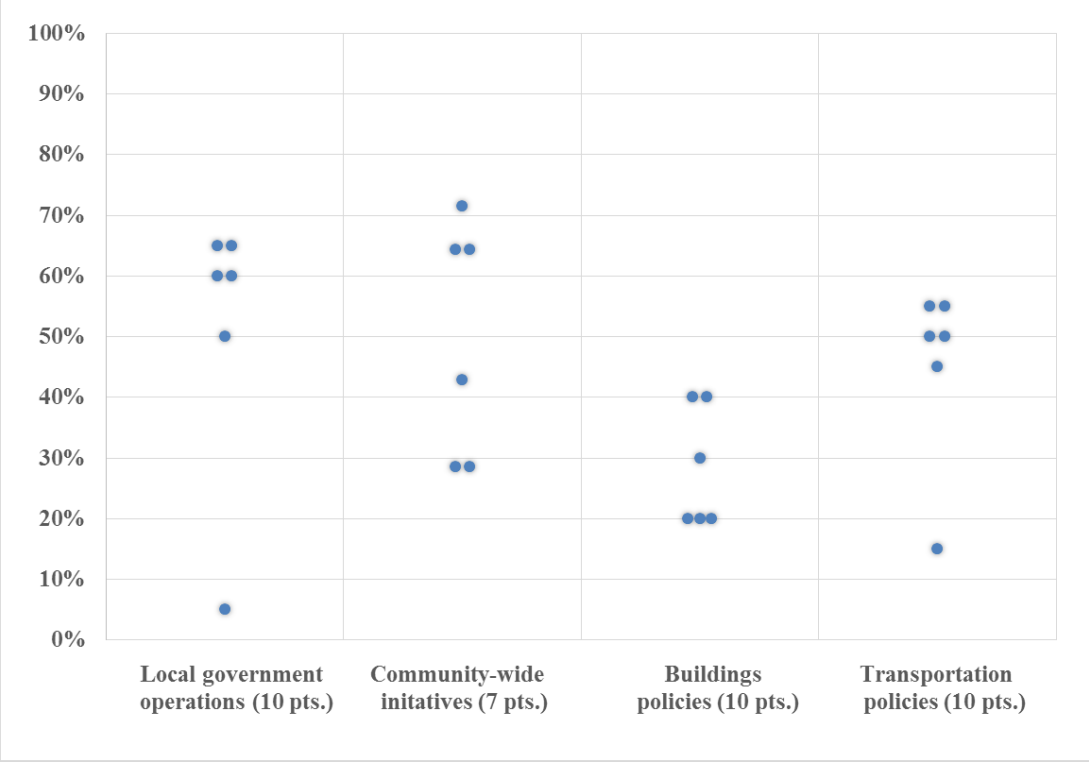

Figure 1. Overall anonymous results of the Taiwan City Index.

are anonymous amongst the cities. We found that each city had areas of strength, with none of the cities proving to be a leader across all energy efficiency sectors.

As can be seen, cities did better in some categories than in others. These results indicate that there are foundational policies that cities can pursue to greatly increase their overall efficiency. For example, all of the cities could improve their building policies, which is the section where cities generally had the lowest scores. Several cities could also increase their activities related to efficiency in local government operations and community-wide initiatives. These scores show that all the cities have areas in which they can improve in each policy area. Furthermore, all the cities can leverage their strengths in order to improve their own policies and act as a leader to other cities. Data limitations may contribute to some of the low scores for cities.

Conclusion

Overall, the localization of the US *City Scorecard* methodology to Taiwanese cities proved a challenging process, yet reaped promising results. We found that the scorecard method is fungible, and can be adapted to different countries with the guidance of knowledgeable partners that intimately know the political landscape. The *Taiwan City Index* shows us that Taiwanese cities have begun to take steps towards energy efficiency policies, but there still is room for more action to be taken.

Among the local governments we have visited, some officials considered the *Taiwan City Index* as a valuable reference to their future self-governance articles. Some officials appreciated that the Index provides them with energy efficiency policy possibilities. Cities were also proud of what they have achieved.

In the coming year, ACEEE and ITRI will work together to expand on this Taiwan City Index research to draft a Local Energy Efficiency Planning Guide for Taiwanese cities. The guide will assist planners in Taiwanese cities by outlining approaches they can take in developing roadmaps to reach energy efficiency objectives.

The *Taiwan City Index* helps cities prioritize actions in order to move forward on policies that will most benefit their city in reducing energy use. This process could also be expanded to more countries who are looking to analyse energy-efficiency policies at the local government level, in order to encourage global cities to champion strong policies to make their cities less energy-intensive, cleaner, healthier, and more efficient.

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