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Applying the Taiwan TIMES Model to Assess Effectiveness of Energy Efficiency Managements

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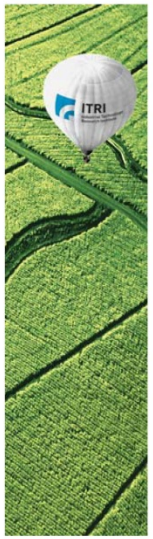

Outline

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Introduction

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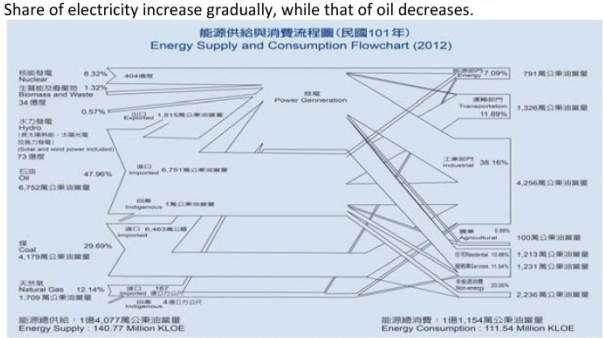
- Taiwan has very limited domestic energy resources and relies on imports for 98% of its total energy supply. Classified by energy form, fossil fuels contributed 89.8% in 2012, nuclear power provided 8.3%, and renewable provided 1.9%.
- Energy consumption of Taiwan is growing 3.5% each year over the past two decades. Share of electricity increase gradually, while that of oil decreases.



Source: Energy Statistics Handbook 2012, Bureau of Energy, MOEA.

Sustainable Energy Policy

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- Taiwan's sustainable energy policy is a triple win solution for Energy, Environment and Economy.
- The objectives of our energy policy are to improve energy efficiency, to develop clean energy and to secure stable energy supply.

Policy Objective

Efficiency — Improving energy efficiency

The goal is to improve **energy efficiency** by more than **2%** per annum, so that when compared with the level in **2005**, **energy intensity** will **decrease 20%** by **2015**. Supplemented by further technological breakthroughs and proper administrative measures, energy intensity will **decrease 50%** by **2025**.

Clean — Developing clean energy

- Reduce nationwide CO_2 **emission**, so that total emission could **return to** its **2005** level between **2016** and **2020**, and further reduced to the **2000** level by **2025**.
- Increase the share of low carbon energy in electricity generation systems from the current 40% to 55% in 2025.

Stable — Securing stable energy supply

Build a secure energy supply system to meet economic development goals, such as 6% annual economic growth rate from 2008 to 2012, and 30,000 USD per capita income by 2015.

Source: Bureau of Energy, MOEA.

Motivation

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- At present, **Taiwan** has announced ***MEPS*** requirements, the ***voluntary energy efficiency labeling program*** and the ***mandatory Energy Efficiency Rating Labeling system*** in order to provide guidance to consumers for the purchase of products with high energy efficiency.

- This paper introduces **the use of market penetration estimation** as a preprocessing method to **improve the input data** for modelling energy use of service and residential appliances in Taiwan.

Model Features

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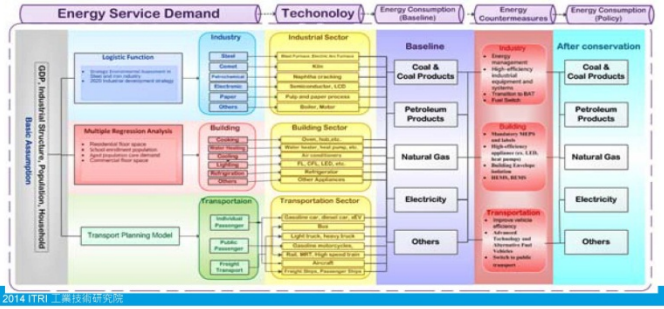
- The Industrial Technology Research Institute (ITRI) established the Taiwan MARKAL model since 1993 with funding support by BOE.
- In order to enhance analysis capabilities, TIMES model was introduced by ITRI in 2007 and in 2010, the Taiwan TIMES model localized database was completed.
- Currently the Taiwan TIMES model database is categorized by 3 major technologies: conversion technology (63 items), processing technology (75 items), and demand technology (256 items)



Methodology

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- Method:
  - Taiwan TIMES Model (The Integrated MARKAL-EFOM System)
  - Market penetration estimation
- 2 sectors:
  - Residential sector
  - Service sector
- Coverage:
  - Taiwan in the period 2010-2030
- Data Sources:
  - Bureau of Energy, Ministry of Economic Affairs
  - Energy Park

Scenario Assumptions

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- Basic Assumptions

Driver	Assumption
GDP	GDP: annual average growth of 3.65% (2010-2030)
Industrial Structure	Share of primary sector of GDP is about 1.4%, secondary decreases little and tertiary sector increases to a share of 72.2% in 2030
Population	Annual growth rate is 0.09%
Household	Mean size of household decreases; annual growth rate of household is 1.31% from 2010 to 2030
Energy Carrier Prices	Based on World Energy Outlook 2012 (IEA) and American Energy Outlook 2012 (EIA)

Source：TaiSEND (2012), Council for Economic Planning and Development (2012), IEA(2012), WEO(2012)

Scenario Assumptions

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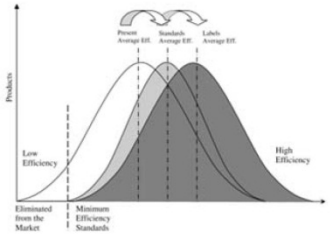
- Estimate the market transformation of energy efficiency managing products:
  - The Industrial Technology Research Institute (ITRI) established the Taiwan MARKAL model since 1993 with funding support by BOE.
  - the use of market penetration estimation as a preprocessing method to improve the input data



$$Pen_{t[t][y]} = MaxPen_{t[t][y]} - \frac{1}{\frac{1}{MaxPen_{t[t][y]}} + e^{\alpha_{t,t}\{y - CogHisYear - SamplePayBack_{t[t][y]}\}}}$$

Note:

$Pen_{t[t][y]}$: Computed penetration into new construction

MaxPen: Computed maximum penetration into new construction

Alpha (α): Parameter controlling shape of the logistic penetration function

CogHistYear: Index of the final year of available historical data

SimplePayback: The equivalent payback year number

Source: US EIA (2011), NEMS Model Documentation.

Scenario Description

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- Scenarios assumptions

Categories	Market transforming scenario
Air conditioner	■ Periodically enhance the energy efficiency standards ➢ the efficiency of MEPS improves 0.5%-1.9% per year ➢ the efficiency of labeling system improves 0.4%-2.7% per year
Illumination	■ Fluorescence lamps: ➢ efficiency with conventional ballast improves 0.4%-0.9% per year ➢ efficiency with electronic ballast improves 0.6%-1.2% per year ■ Fluorescent Lamps with embedded ballasts: ➢ The annual efficiency improvements of MEPS is 0.7%-0.9% ➢ the voluntary labeling standard is 1.2%-1.8% ➢ the mandatory efficiency rating labeling standard is 1.1%-1.6%
Hot water (gas burning water heaters)	■ The efficiency in improvements of MEPS is 0.9% ■ The voluntary labeling standard is 0.3%.
Cooking (Gas Stove)	■ The average efficiency of gas stoves is 45% in Taiwan ■ The voluntary energy labeling standard is 49% and will be revised to 52% in 2020.
Refrigerator	■ The efficiency standards improve 1.7% per year.

Scenario Results (1/7)

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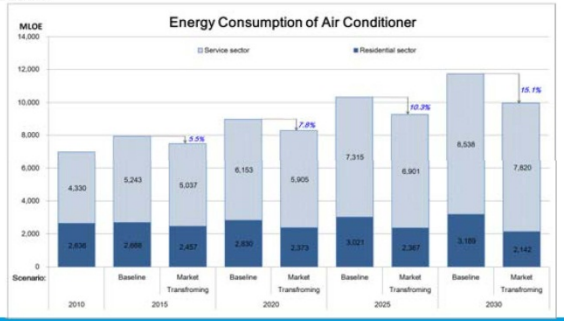
- Primary Energy Supply
  - The total energy supply in 2030 is growth 35% in TSD scenario. In another scenarios of technology development (TND and TAD), the energy supply in 2030 will be less 8.0% and 11.1% relative to TSD scenario.
  - Of this, coal is the main energy source decreased, representing 85% of total reduction.



Scenario Results (2/7)

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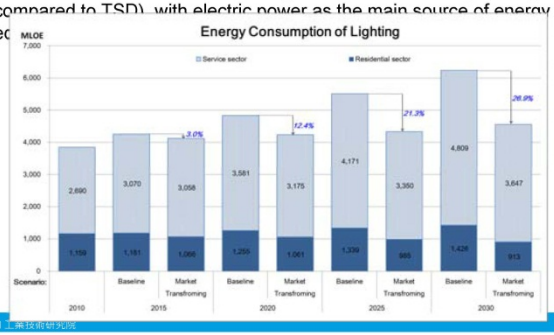
- Total Domestic Energy Consumption
  - Energy consumption continues to rise in the future，in the scenario of technology stagnant, the annual growth rate between 2010 and 2030 is 2.2%.
  - In the scenario of technology development, future energy consumption in TND and TAD scenario will reduce by 8.9% and 13.5% respectively in 2030 (compared to TSD), with electric power as the main source of energy rec



Scenario Results (3/7)

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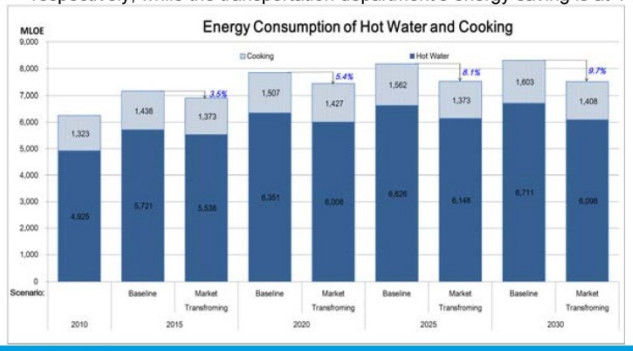
- Sector Energy Consumption
  - Energy saving capabilities of the industrial, residential and services sectors are most significant.
  - Under TND and TAD scenario each saves energy by 34-47% and 42-53% respectively, while the transportation department's energy saving is at 4-6%.



Scenario Results (4/7)

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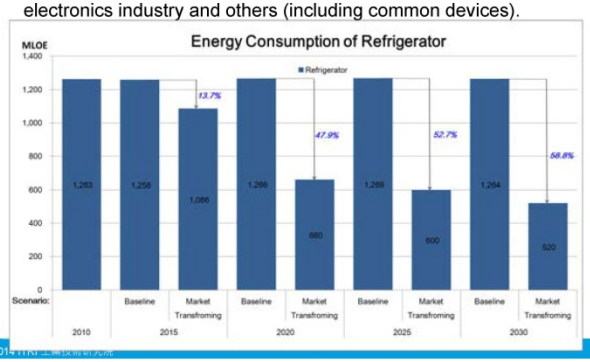
- Industrial Energy Consumption
  - The average annual growth rate of industrial sector energy consumption in 2030 will be from 1.9% in the TSD scenario, decrease to TND and TAD scenario respectively 1.6% and 1.3%..
  - Of this, the most significant energy saving contributions are shown in the electronics industry and others (including common devices).



Scenario Results (5/7)

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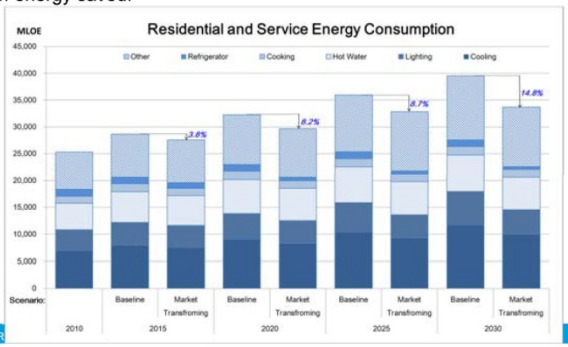
- Residential and Services Energy Consumption
  - The energy consumption in 2030 of TND and TAD scenario decrease 18.9% and 23.7% respectively relative to TSD scenario.
  - Of this, the most energy conservation potential is space cooling (energy-saving contribution to 48%), followed by lighting which contributes to 21-28% of energy saved.



Summary and Conclusions

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1. In the scenarios of technological development (TND & TAD), government's target of reducing energy intensity by 2% annually can be achieved.
2. However, if a goal of 50% decrease in energy intensity will be reached by 2025 compared to 2005, much aggressive measures such as higher efficiency of new technologies and market penetration approaches as well as relevant incentives must be taken into the context of government's energy policy.
3. This research is just based on the assumptions of optimizing industrial structure and implementation of energy-saving measures, its effectiveness in the future still have lots uncertainties lay ahead.
4. To achieve policy objectives, more in-depth analysis regarding the possibility of actual implementation on technology development and the effects of financial mechanism (ex. energy tax) on energy intensity should be taken into account in the scopes of further research .