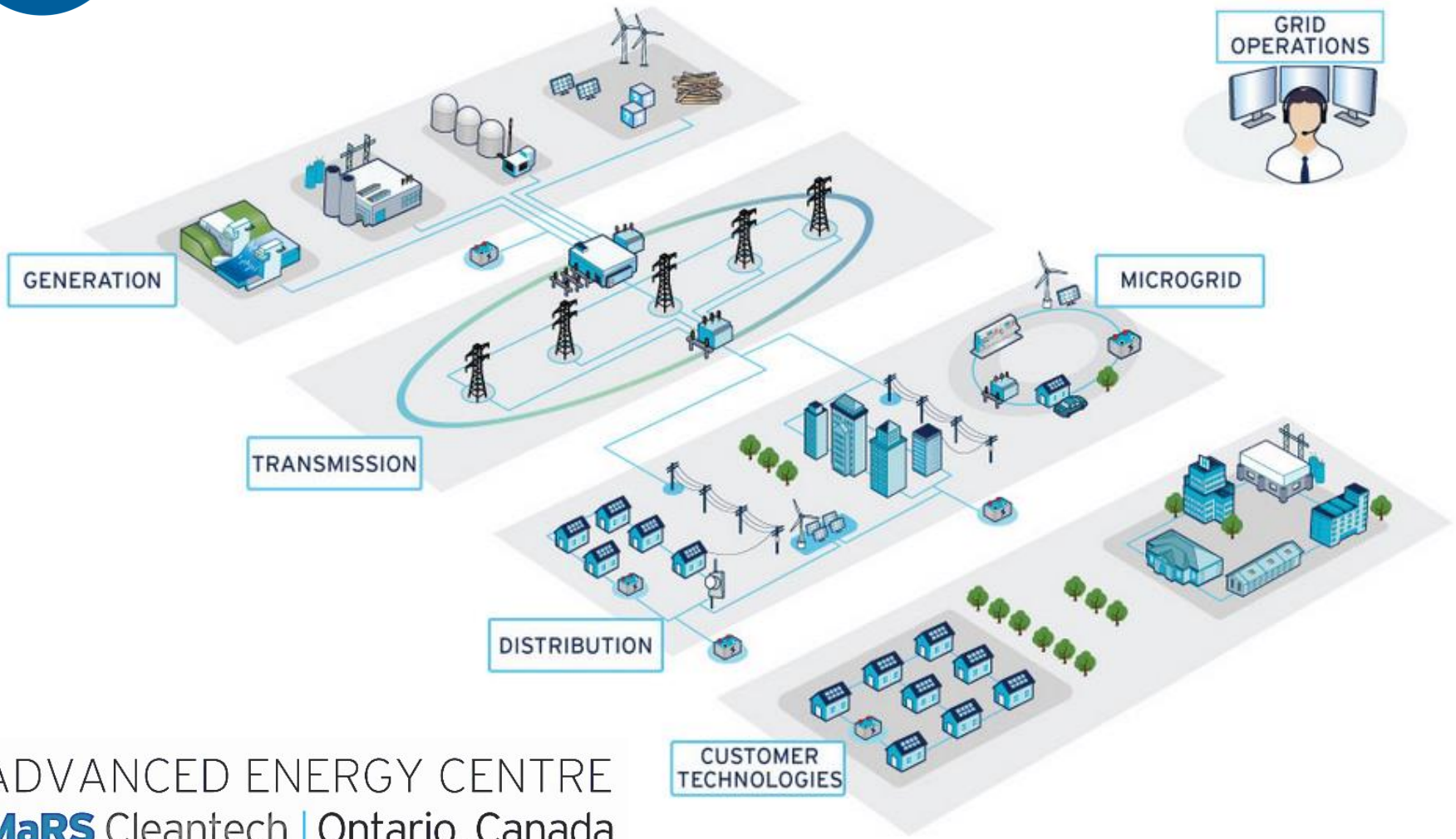
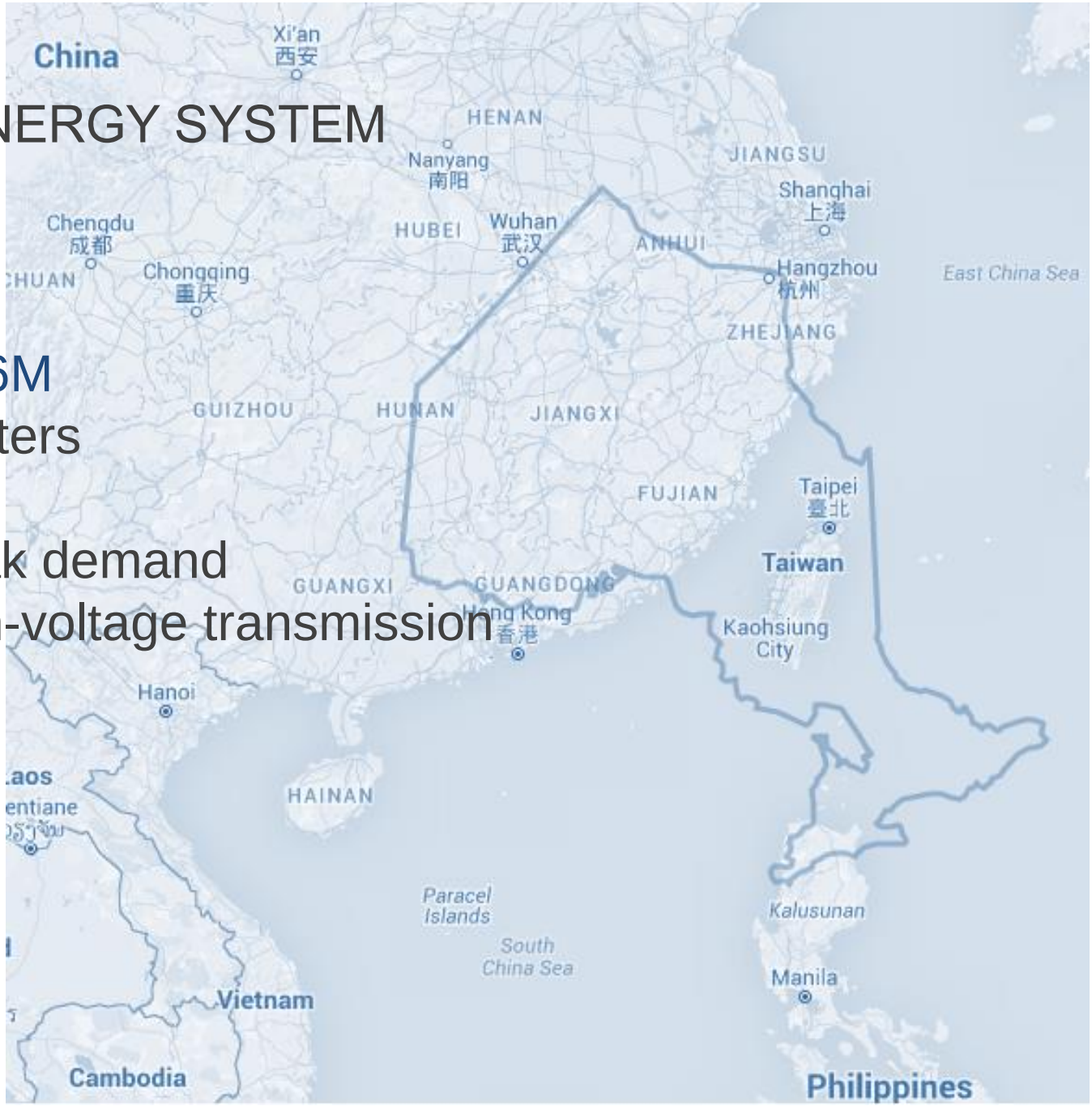
Global Green Economy: Status & Outlook



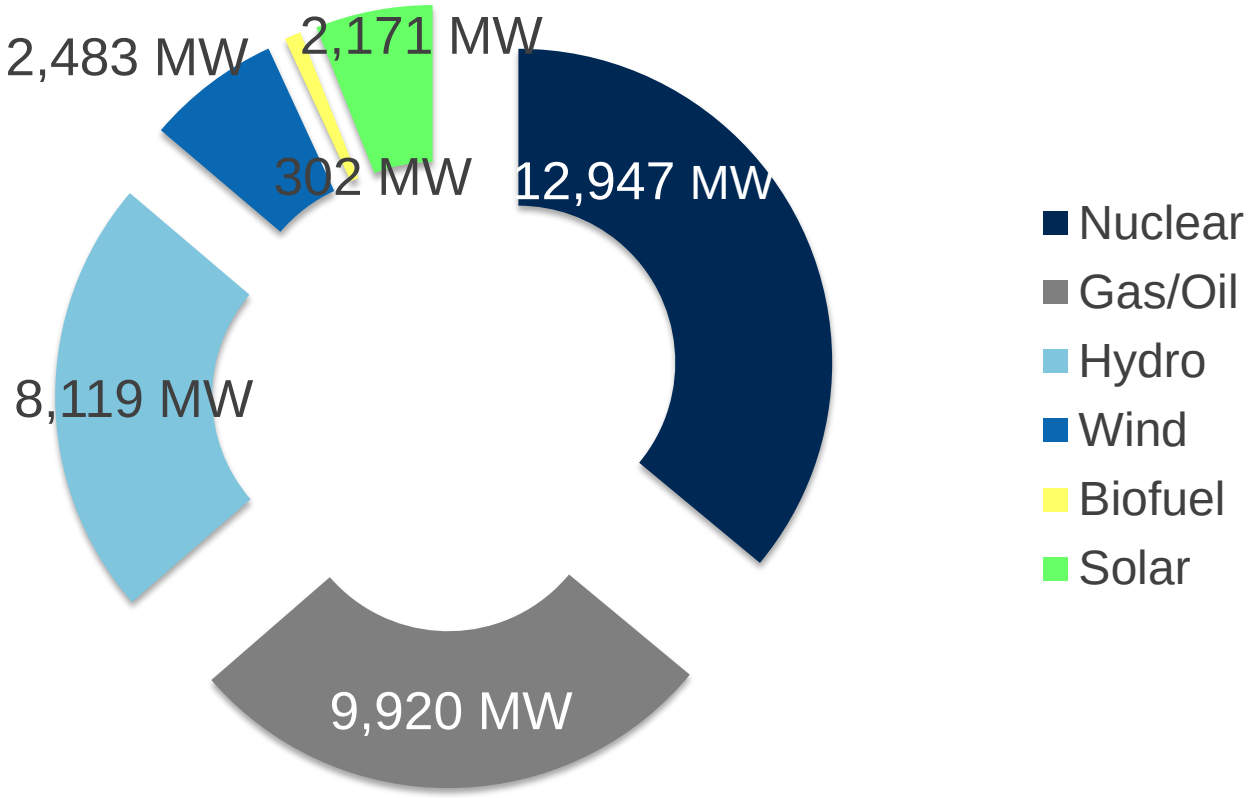
ADVANCED ENERGY CENTRE
MaRS Cleantech | Ontario, Canada

ONTARIO'S ENERGY SYSTEM

Population 13.6M
4.8M smart meters
73 LDCs
25,000MW peak demand
29,000 km high-voltage transmission

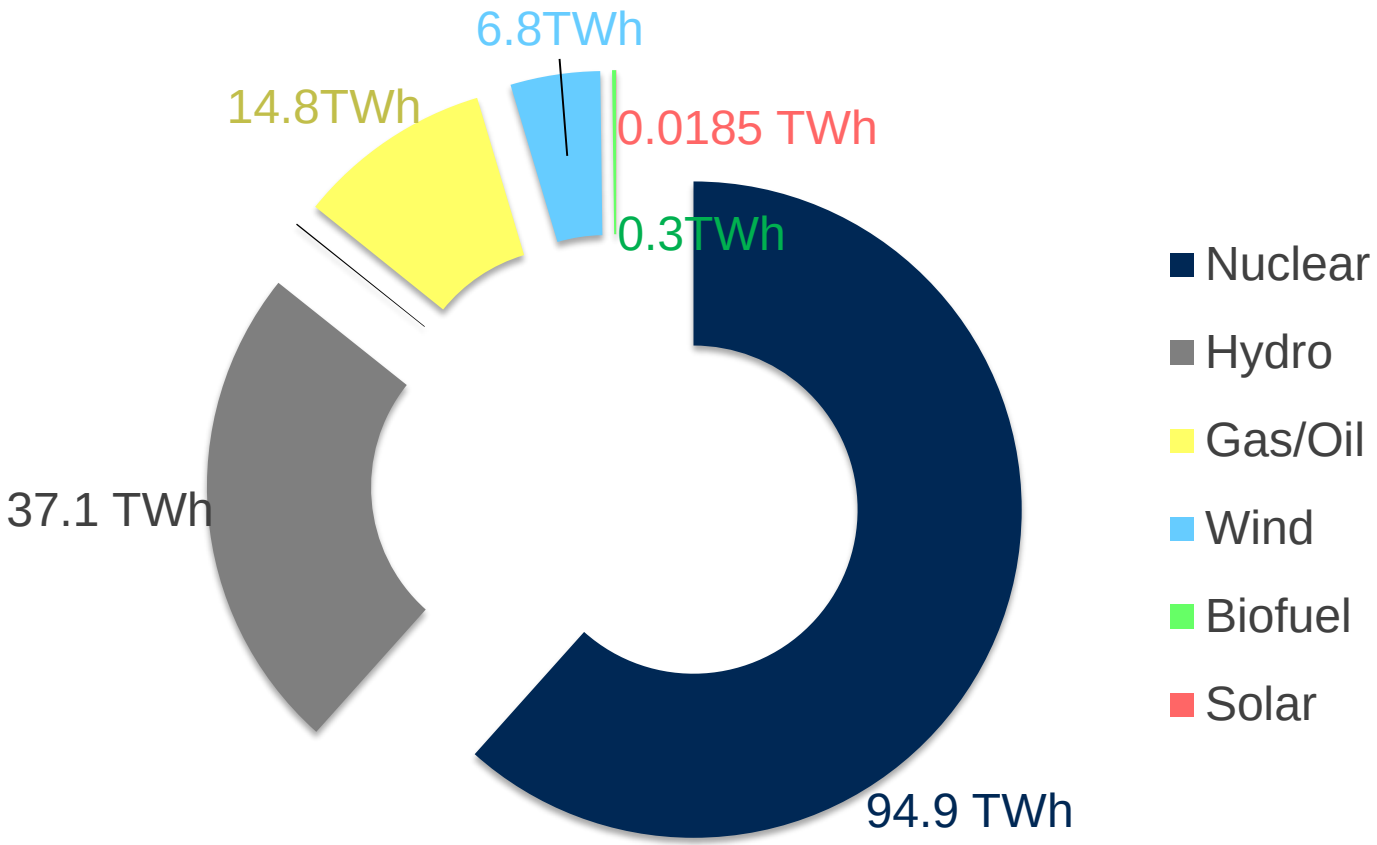


ONTARIO'S INSTALLED GENERATION CAPACITY



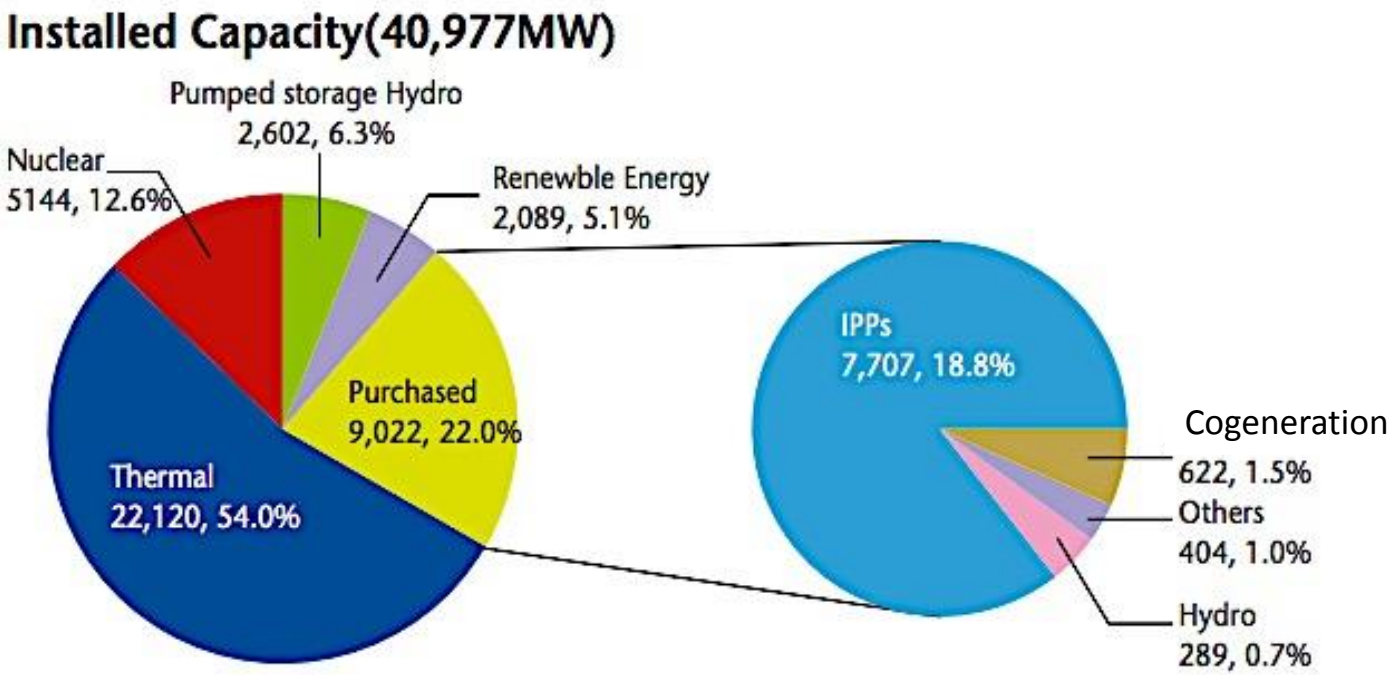
*33,771 MW of Installed Generation, 2014

ONTARIO'S ENERGY MIX



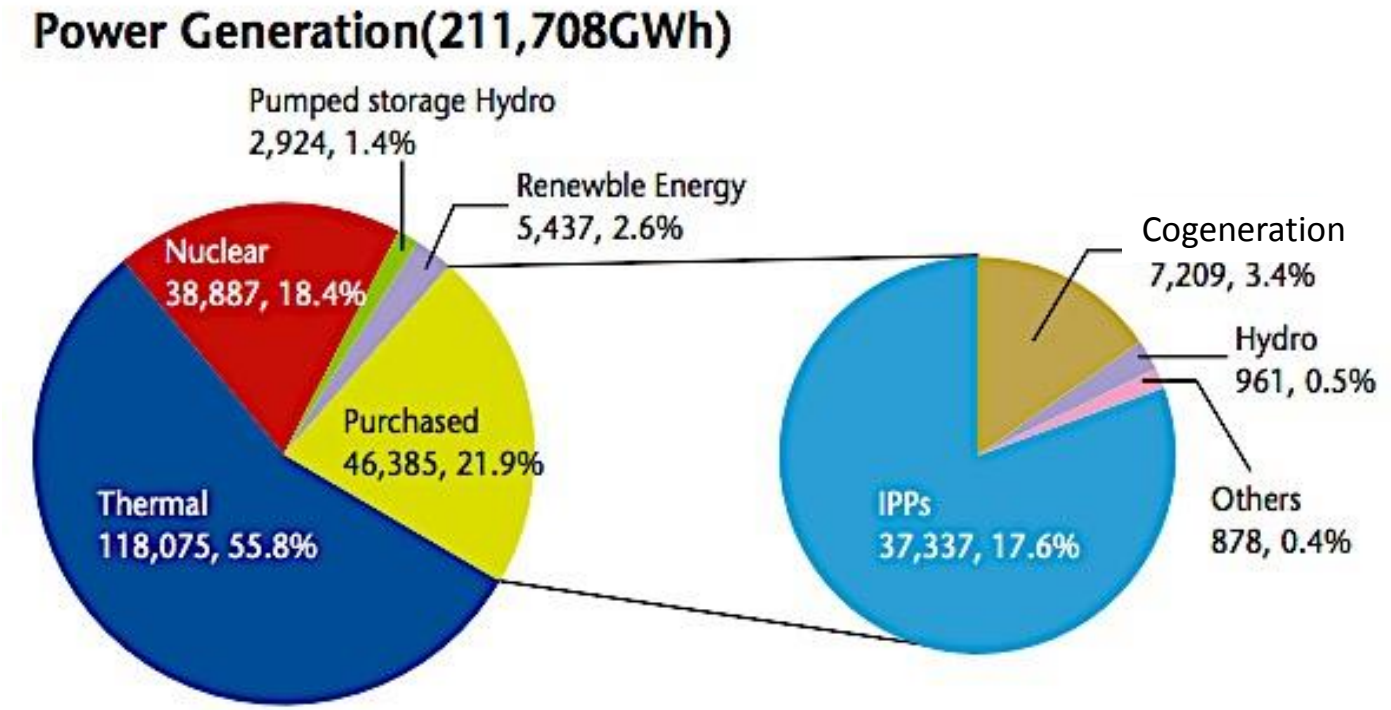
*153.92 TWh Consumed in Total, 2014

TAIWAN'S INSTALLED GENERATION CAPACITY



Source: Taiwan Power Company Sustainability Report (2013)

TAIWAN'S ENERGY MIX



Source: Taiwan Power Company Sustainability Report (2013)

WHY CHANGE IS INEVITABLE IN THE ENERGY SECTOR

DRIVERS OF CHANGE

INCREASING WEATHER VOLATILITY

DECLINING AVERAGE DEMAND

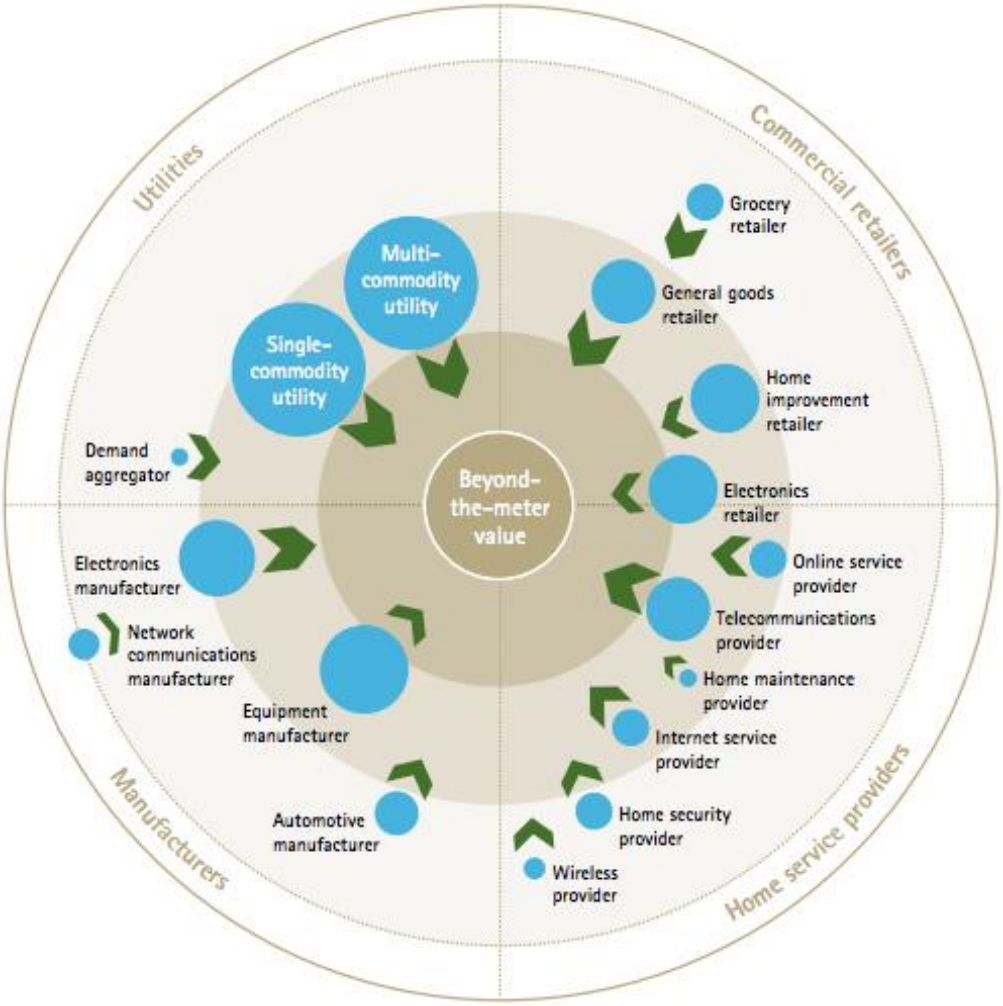
COMPETITION FROM NON-SECTOR ACTORS

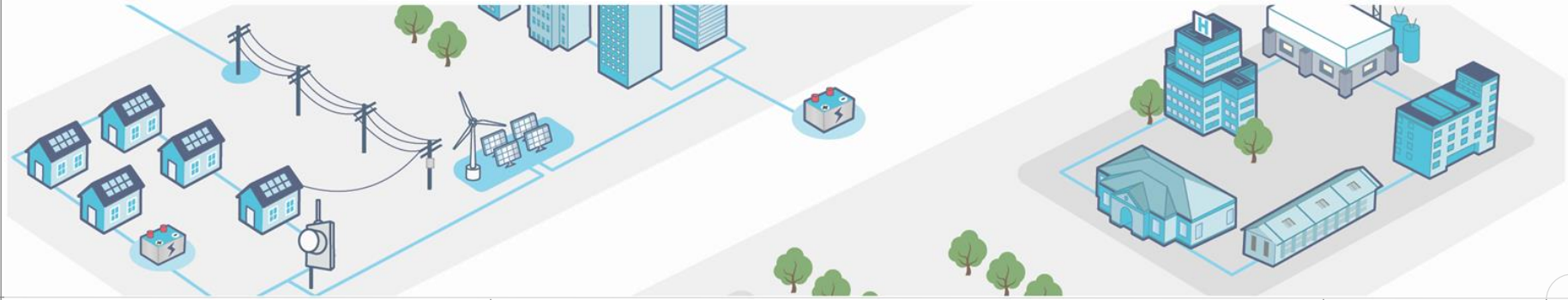
DISTRIBUTED RENEWABLES

DECLINING COST OF STORAGE

ELECTRIC VEHICLES

INCREASINGLY ENGAGED CONSUMERS

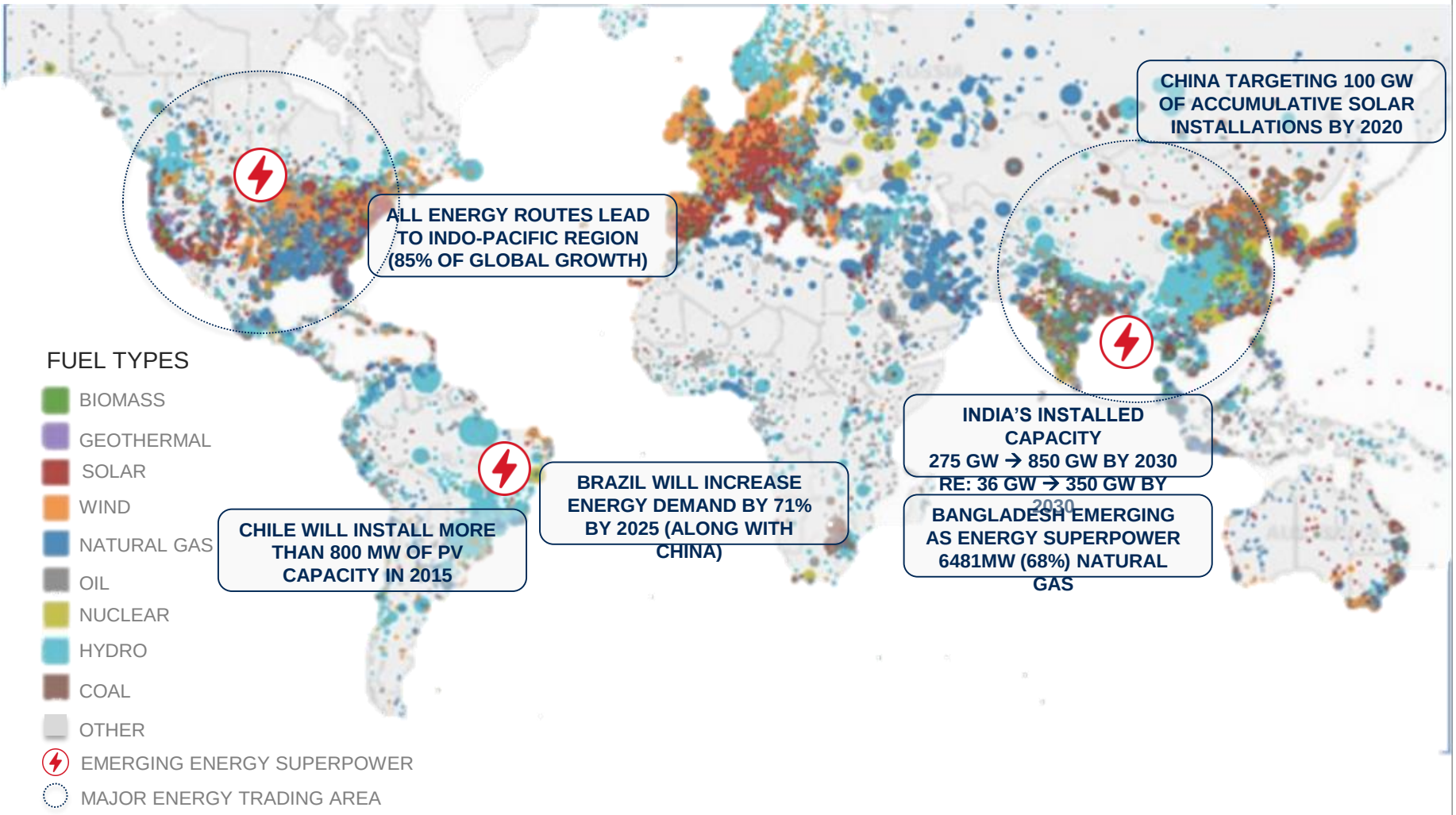

Utilities
Commercial retailers
Manufacturers
Home service providers
Multi-commodity utility
Single-commodity utility
Demand aggregator
Beyond-the-meter value
Electronics manufacturer
Network communications manufacturer
Equipment manufacturer
Automotive manufacturer
Grocery retailer
General goods retailer
Home improvement retailer
Electronics retailer
Online service provider
Telecommunications provider
Home maintenance provider
Internet service provider
Home security provider
Wireless provider



GEOPOLITICAL CHANGE

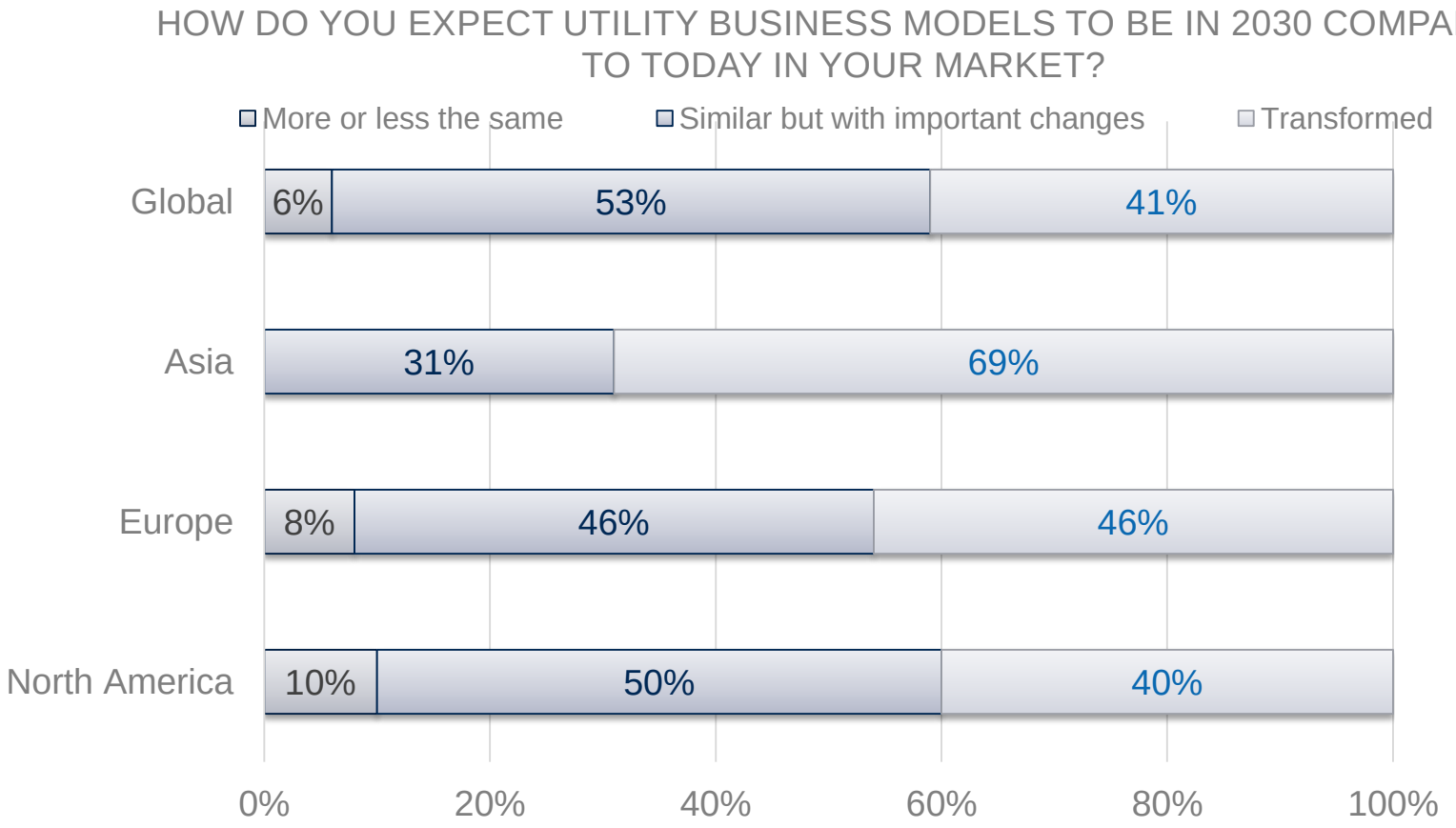
THE "NEW MIDDLE EAST"- NAT. GAS EXPORTS US 492,677 MW

SOUTHEAST ASIA ENERGY TRADING AREA THE SIZE OF NORTH AMERICA



Source: Power Plant Data Source, UDI Database, 2012

THE MAJORITY OF UTILITY EXECUTIVES ACKNOWLEDGE THE NEED TO CHANGE



Source: 13th PwC Annual Global Power & Utilities Survey

Ontario Energy Board
Commission de l'énergie de l'Ontario

ieso

Sustainable Development Technology Canada

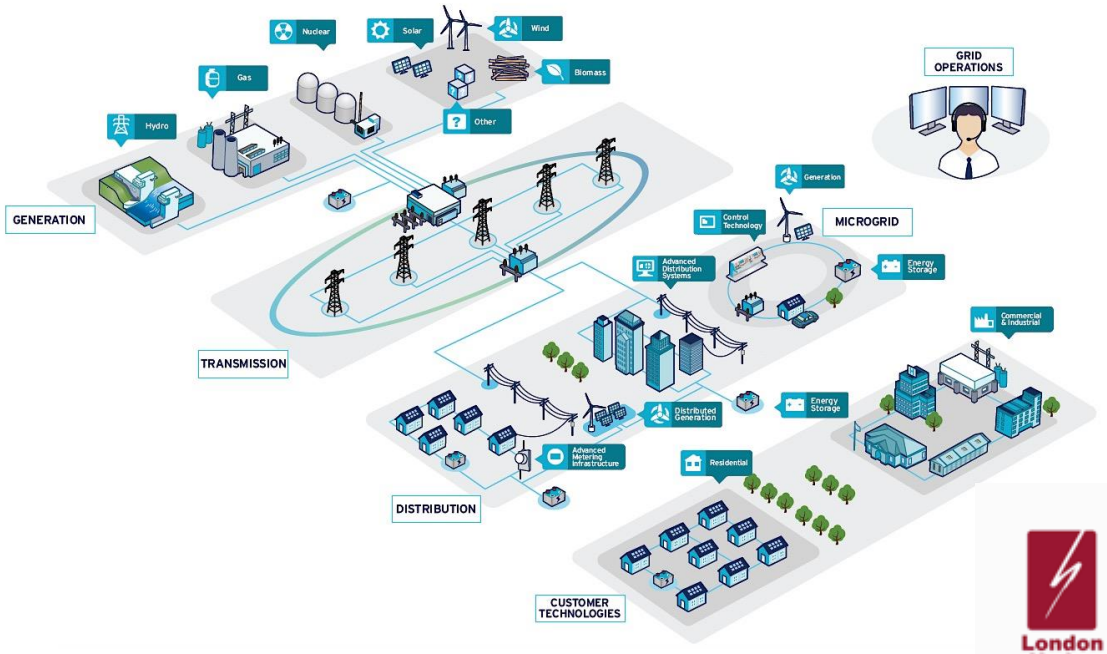
EDC

Ontario
Ministry of Economic Development and Trade

Foreign Affairs, Trade and Development Canada

Regulators

Government



Innovators

zerofootprint

valta

ecamion

WATTSLY

enbala
POWER NETWORKS

morgansolar

Utilities

London Hydro

TORONTO HYDRO

HydroOttawa

Guelph Hydro Inc.

MILTON HYDRO

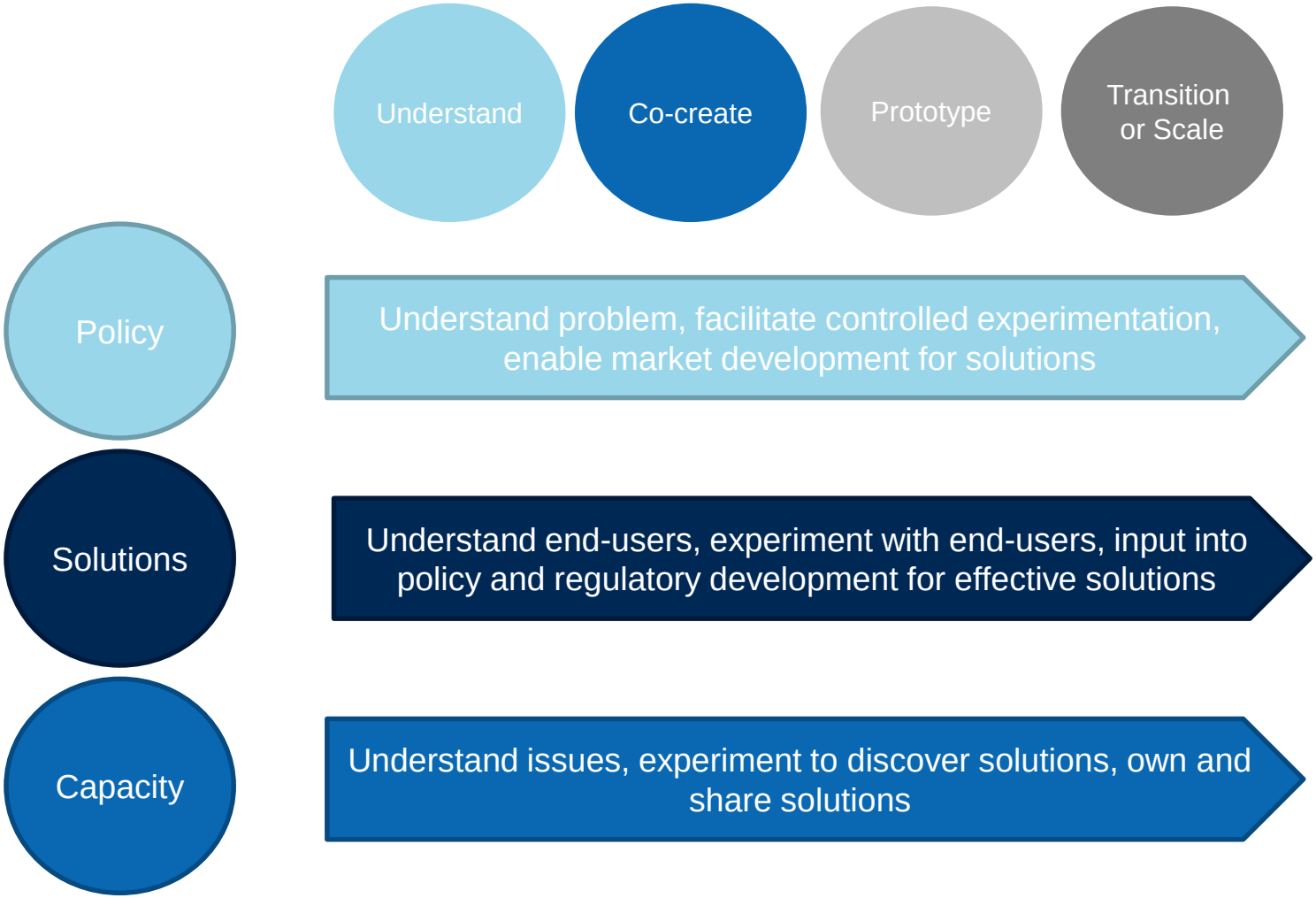
hydro one

Power Stream

DEVELOPING TALENT • GROWING VENTURES • OPENING MARKETS

WHY DON'T WE ADOPT INNOVATION FASTER IN THE ENERGY SECTOR?

A MODEL FOR SYSTEMS CHANGE IN A REGULATED SECTOR

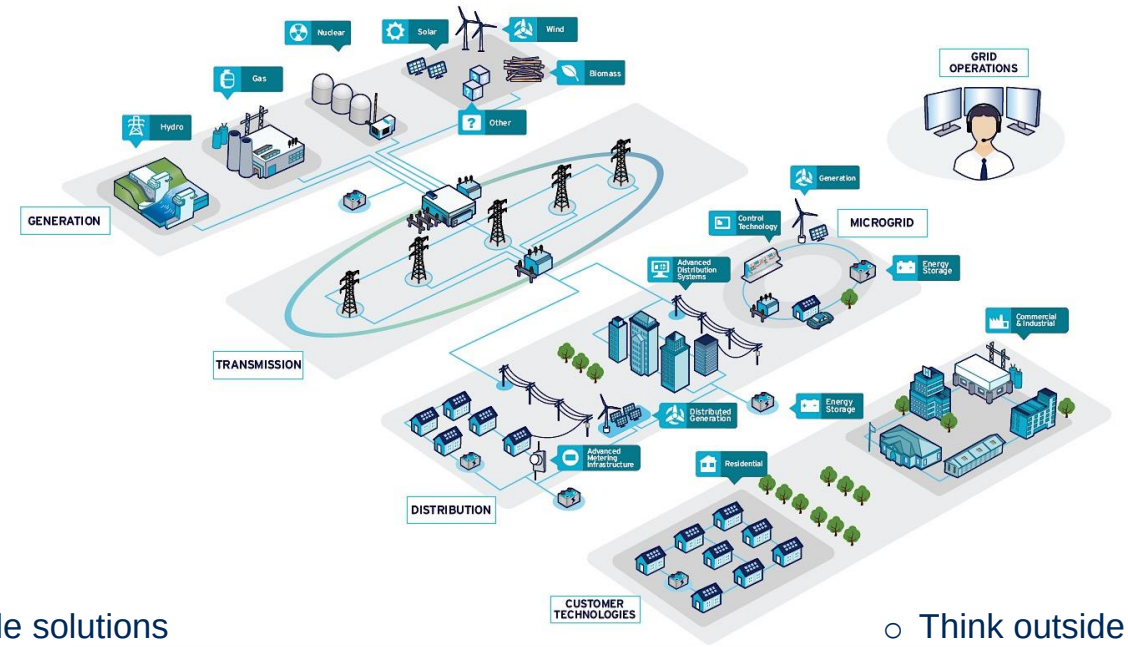


- Draw lines around monopoly
- Create rewards for risk
- Standards to shape status quo

Regulators

- Set goals, let the sector respond
- Address barriers
- Resist the need to intervene
- Expose markets, let them decide

Government



Innovators

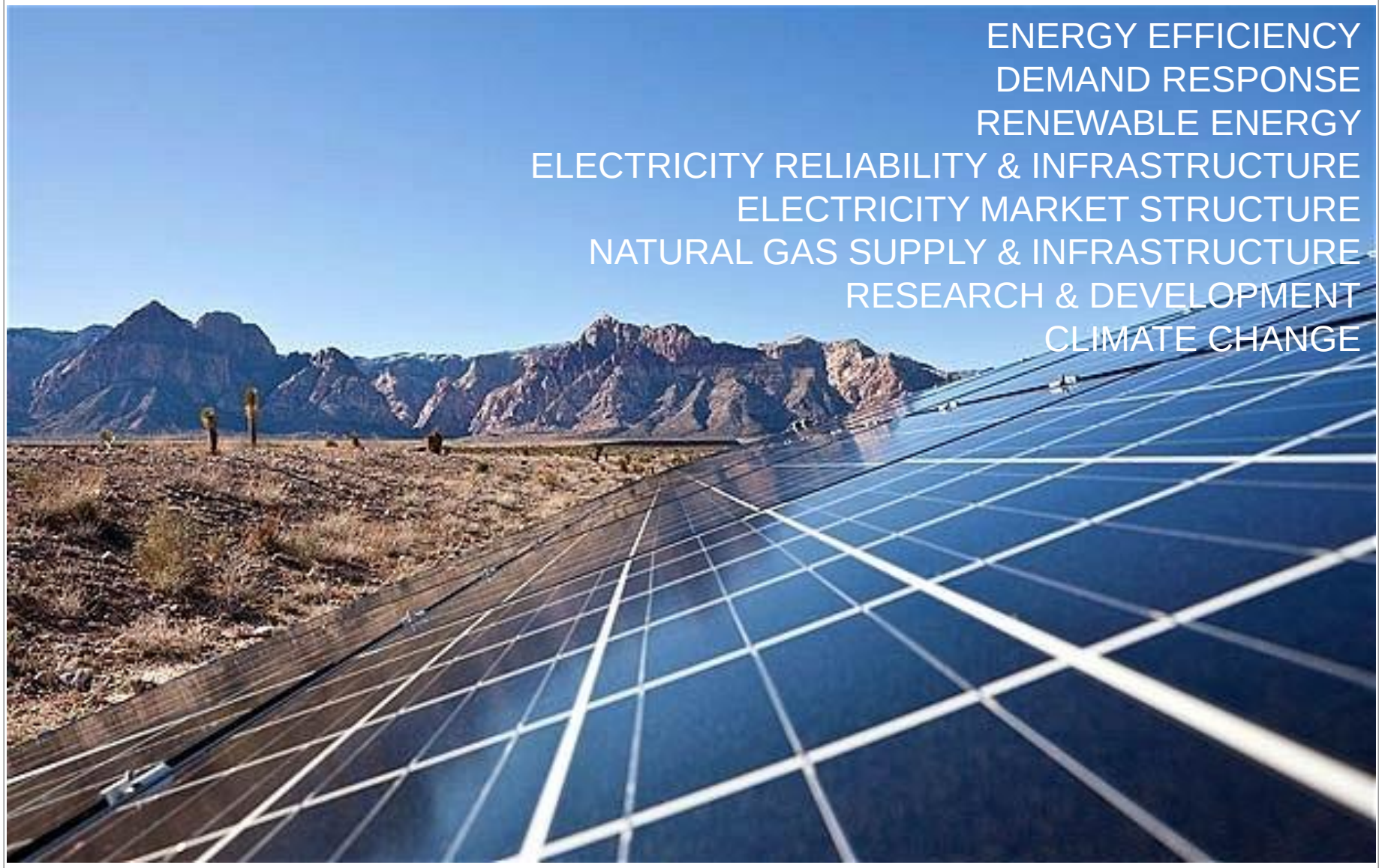
- Partner for whole solutions
- Create real and viable alternatives

Utilities

- Think outside of traditional constraints

ie. What if you couldn't sell in KwH?

ENERGY INNOVATION: CALIFORNIA



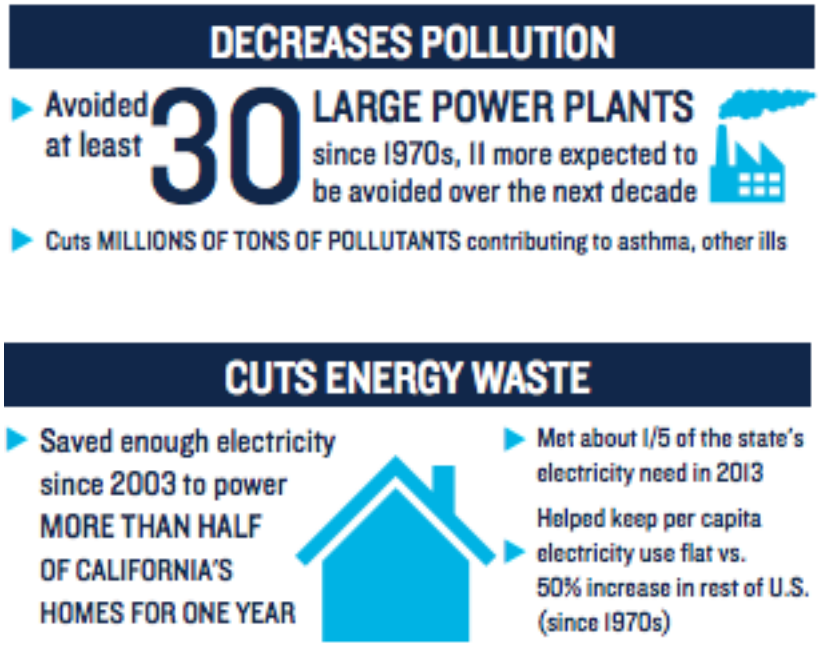
ENERGY EFFICIENCY

GOAL (2005)

IMPROVE EFFICIENCY

- Implement actions to improve building performance & reduce grid-based electrical energy purchases in all State and Commercial buildings by **20% by 2015**
- Increase the availability of State-sponsored **low-interest loans** for energy efficiency and clean distributed projects
- Update and augment utility evaluation, measurement and verification protocols to assure that energy efficiency continues to be fully **integrated into resource planning**

RESULT (2015)



Source: NRDC Report, "California's Golden Energy Efficiency Opportunity"

ECONOMIC DEVELOPMENT

GOAL (2005)

AFFORDABILITY & COST SAVINGS

- Energy must be **affordable** to households, businesses and industry, and motorists
- Require that all **cost-effective energy efficiency** is integrated into utilities' resource plans
- Expand efforts **to improve public awareness** and adoption of energy efficiency measures.
- Provide affordable energy solutions to **disadvantaged customers**

RESULT (2015)

SAVES CALIFORNIANS MONEY

- Efficiency programs saved $12 billion after costs (2003-2013)
- Research projects yielded $446 for every $1 invested
- Newest building codes to save $6,000 per house
- Codes and standards saved a total of **$75 billion** (since 1970s)

CREATES JOBS, SPURS ECONOMY

- Efficiency jobs grew 15% compared to 2% economy-wide (2002-2012)
- California produces 2x benefit for every unit of electricity compared to the rest of U.S.

HELPS LOW-INCOME CUSTOMERS

- Low-income efficiency programs served almost **3 MILLION HOUSEHOLDS** (since 2003)
- Saved enough electricity to power **90,000 HOMES** and enough natural gas for nearly **80,000 HOMES** for 1 year

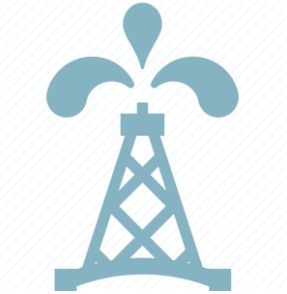
Source: NRDC Report, "California's Golden Energy Efficiency Opportunity"

CLIMATE CHANGE

GOAL (2005)

GHG EMISSION REDUCTIONS

- **50%** reduction of fossil fuels by cars and trucks
- **40%** reduction of emissions below 1990 levels by 2030



RESULT (2015)

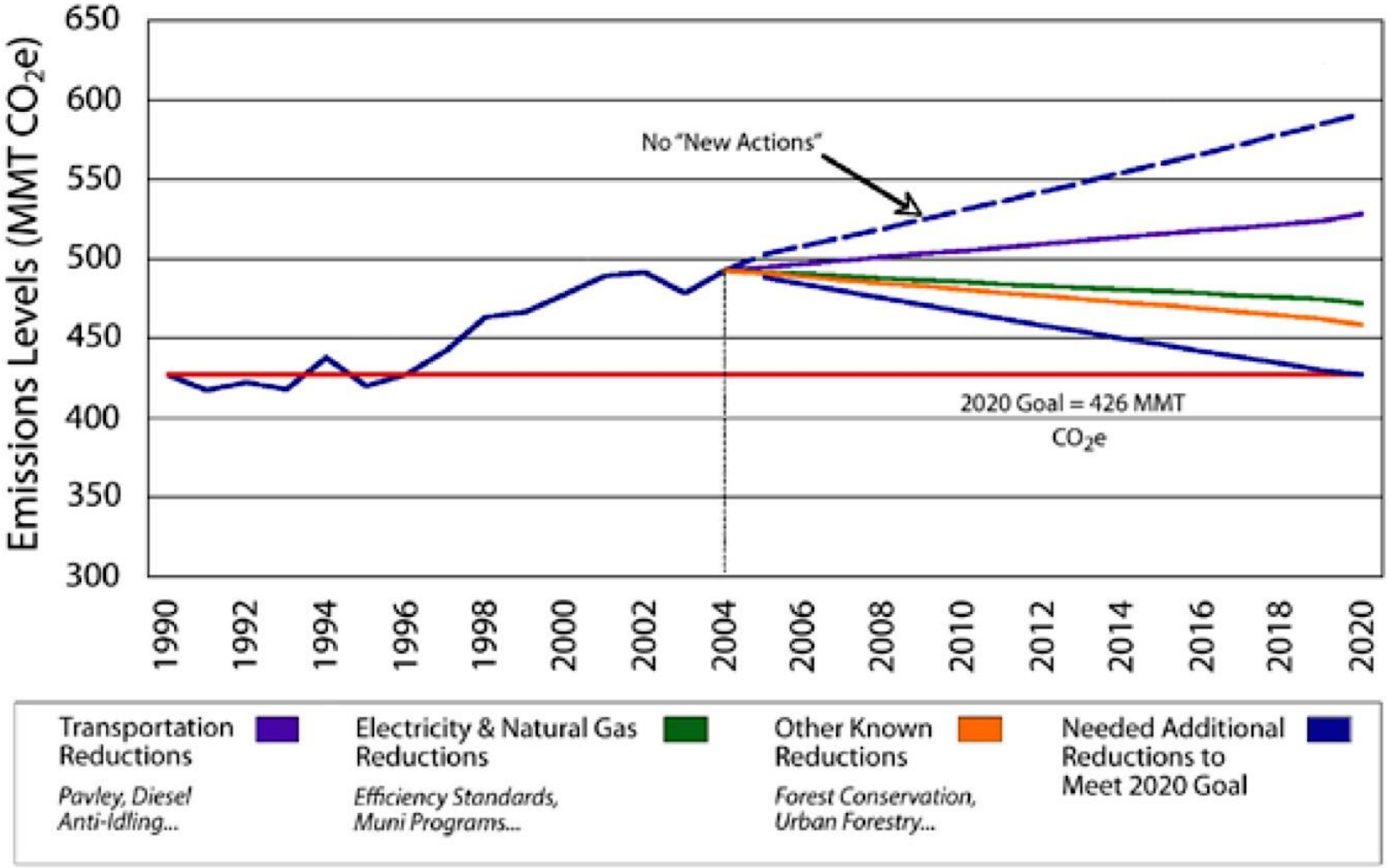
HELPS MEET CLIMATE GOALS

- Slashed **30 MILLION** metric tons of CO_2 pollution, equal to annual emissions of 6 MILLION cars (since 2003)

- Cuts one of the largest sources of California's greenhouse gas emissions

Source: NRDC Report, "California's Golden Energy Efficiency Opportunity"

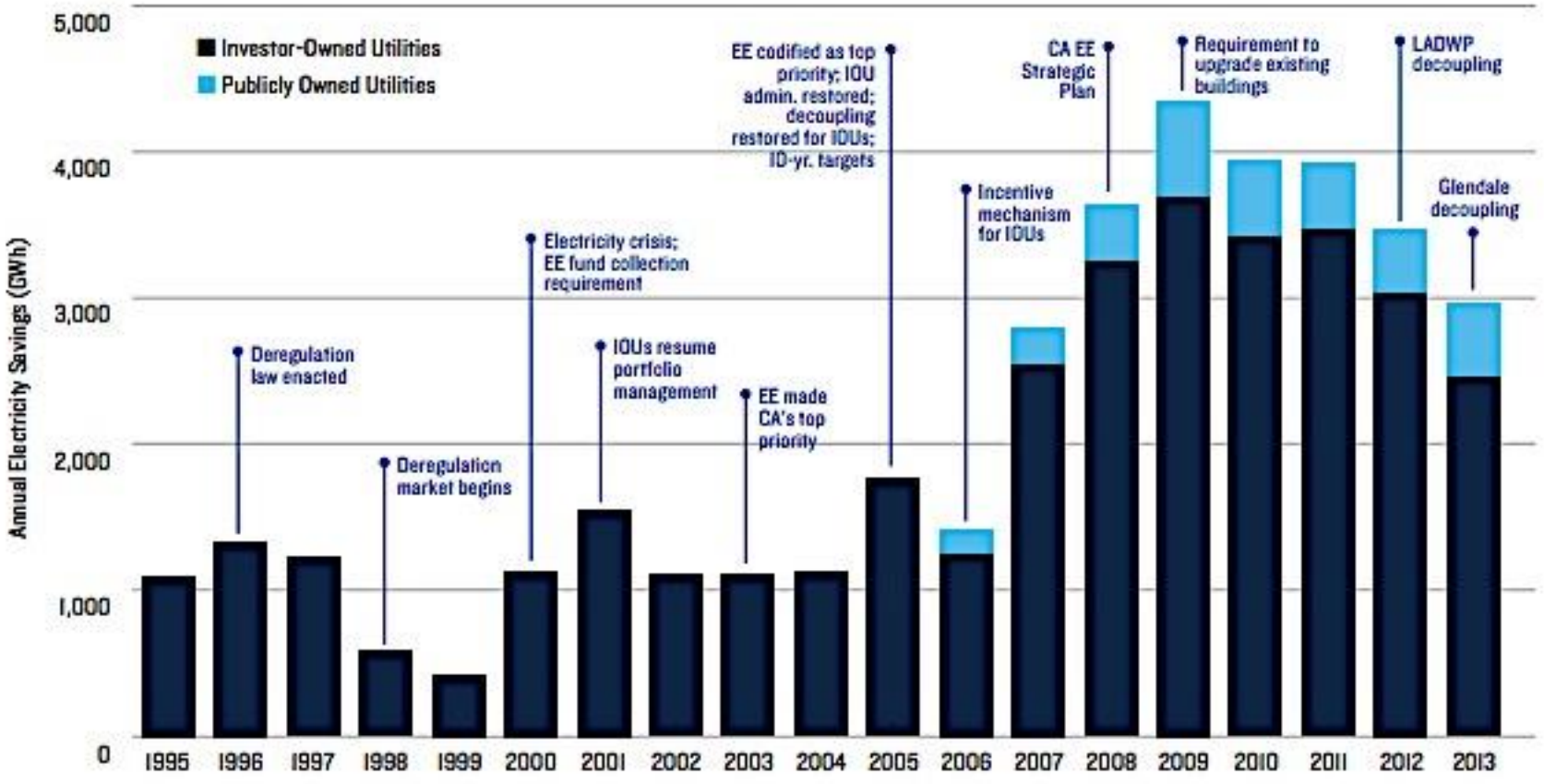
CLIMATE CHANGE



Source: California Energy Commission

ENERGY INNOVATION: CALIFORNIA

EE SAVINGS & POLICIES



Source: NRDC Report, "California's Golden Energy Efficiency Opportunity"

REPRESENTATIVE ACTIVITIES

POLICY

- Planning for emissions reduction goals in 2050
- Adopt regulations to implement Low Carbon Fuel Standards
- Making recommendations RE: how electricity and natural gas sectors should be included in AB 32 framework

SOLUTIONS

- Exploring natural gas storage options
- Monitoring and assessing the global natural gas market and its impacts on LNG deliveries and prices
- Encouraging technological development for carbon capture and sequestration
- Evaluating need for a combined heat and power policy

CAPACITY

- Implementing incentives for solar water heating
- Develop a strategy investment plan for alternative fuel and vehicle incentives
- Establish load-management standards to establish demand- response infrastructure

Source: 2008 Energy Action Plan, State of California

ENERGY INNOVATION: GERMANY

PENETRATION OF RENEWABLES

27% of electricity production is renewable energy

Menu of incentives & standards to support new technologies

Feed-in-Tariffs (FIT) for renewables

RESULTS

- Overcapacity→ wholesale prices fell, utility profits impacted
- Consumer prices increased

ABOVE-MARKET PRICES FOR RENEWABLES

SUBSIDIZED BY SURCHARGE TO CUSTOMER

SURCHARGE INCREASES

FLOOD OF RE INTO SYSTEM

GRID OPERATORS MUST BUY BY LAW

- Renewables undercut natural gas on price
- Utilities turned to coal generation to replace nuclear for base load
- Germany increased CO_2 emissions

Source: Energy Innovation, Policy & Technology LLC

ENERGY INNOVATION: GERMANY

GHG EMISSIONS

40% reduction in greenhouse gas emissions by 2020

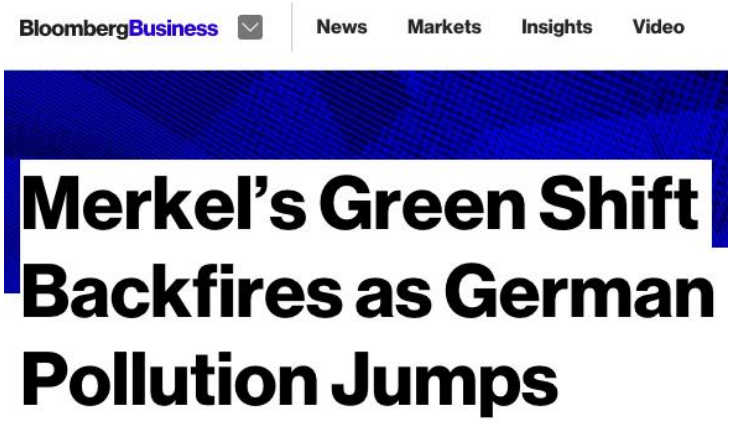
Building regulations

2022 deadline to phase out nuclear

RESULTS

- Coal became cheaper than natural gas
- CO_2 emissions increased

  931m tonnes of CO_2 (2013) up from 917m tonnes (2012)


BloombergBusiness | News | Markets | Insights | Video

Merkel's Green Shift Backfires as German Pollution Jumps

Source: Bloomberg Business, CleanTechnica

ENERGY INNOVATION: GERMANY

ENERGY EFFICIENCY

Established building energy efficiency label

Tax incentives for sustainable energy investments in buildings

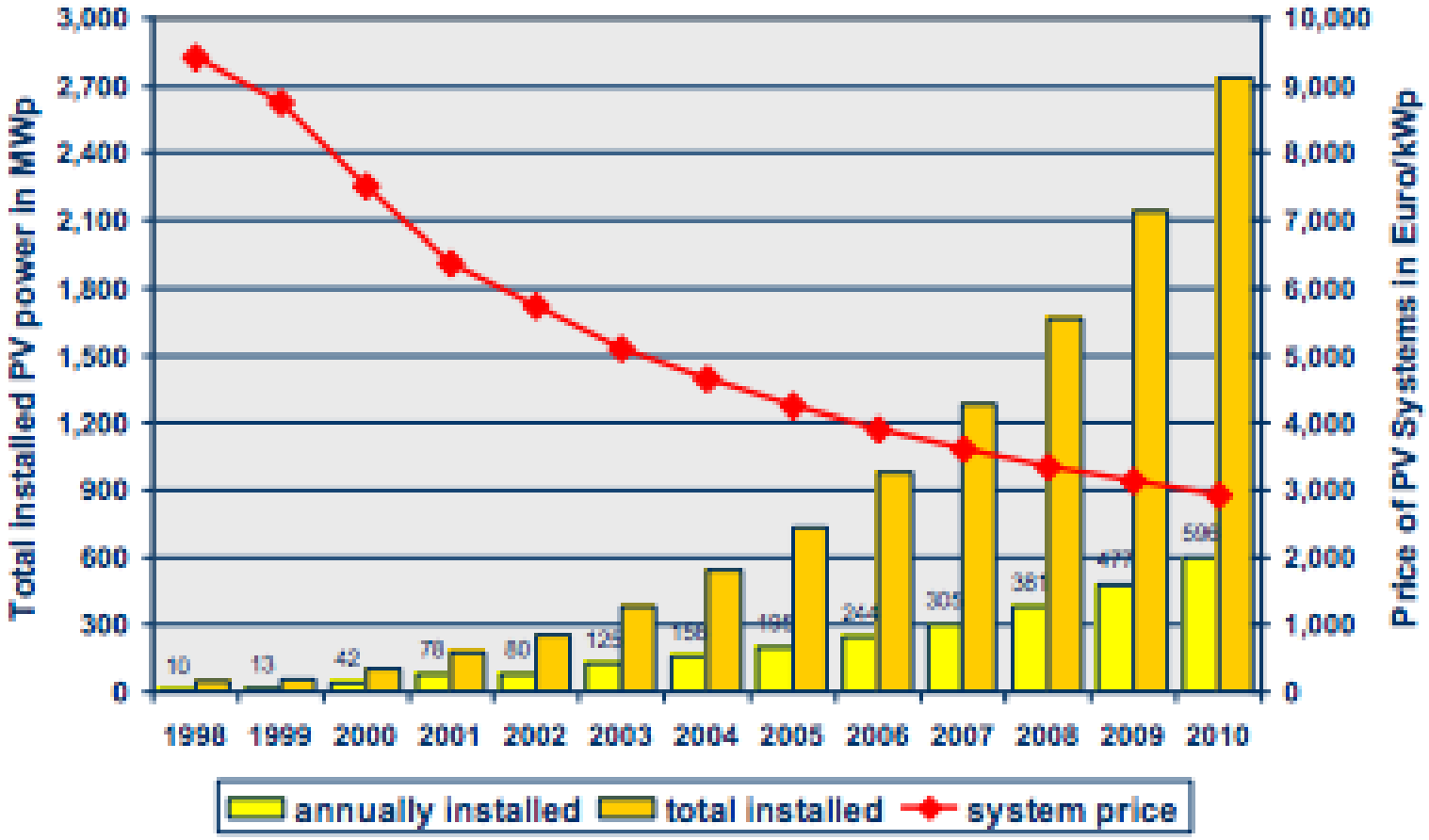
Goal of 1m e-cars on German streets by 2020

RESULTS

- Residential and non-residential building owners rarely (35%) use the Energy Performance Certificate (EPC), despite having high awareness of it (81%)
  - Only required to display the Certificate when requested by the purchaser
- Only 44% found the EPC trustworthy (skeptical)
- Germany is behind on e-cars
  - Only 0.6% of all new cars sold in Germany in Q1 2015 were electric v. Norway at 20%

Source: Energy Innovation, Policy & Technology LLC, Climate Policy Initiative Report

ENERGY INNOVATION: GERMANY



Source: Johns Hopkins University, CSIS.org

KEY TAKEAWAYS

1. Let markets decide

2. Focus on defining the outcome, important not to be wedded to a solution

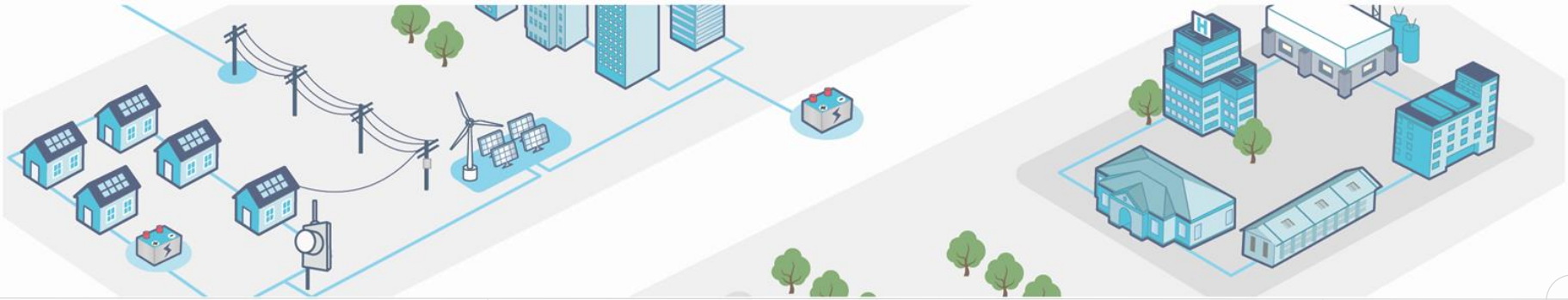
3. Adopting innovation is not only about policy- consider three dimensions: **policy, solutions and capacity**

4. Solutions adoptable at scale requires systems change

5. Consider which approaches to market are proven

“I’m Not Really a Fan of Disruption; I’m Just a Fan of Things Being Better”

-Elon Musk



Thank You

ADVANCED ENERGY CENTRE