1. Scenario Planning:

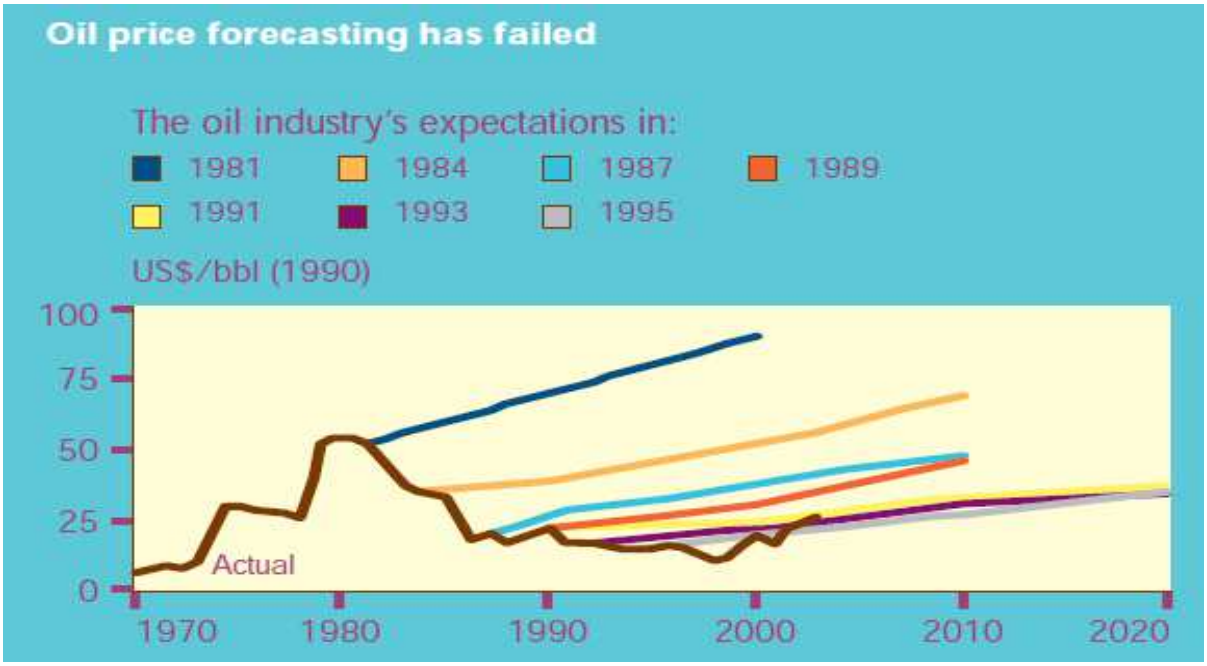
Concept & Principle

Uncertainty

The Way to Look Future

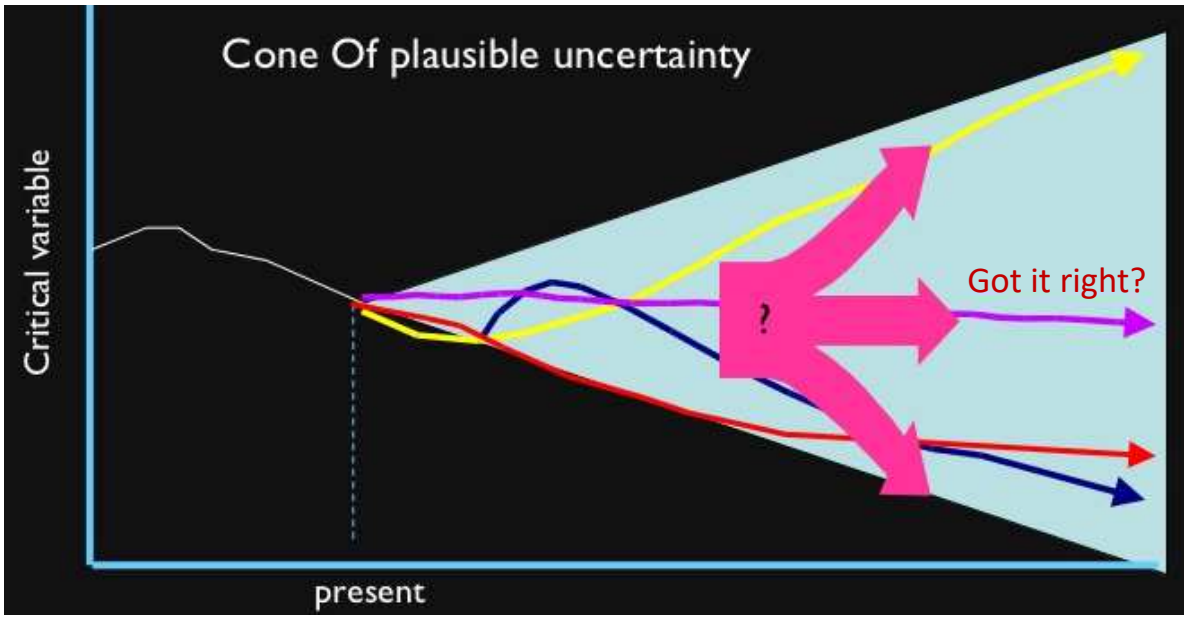
Samples of Scenario Making for Future Energy

Future is unpredictable



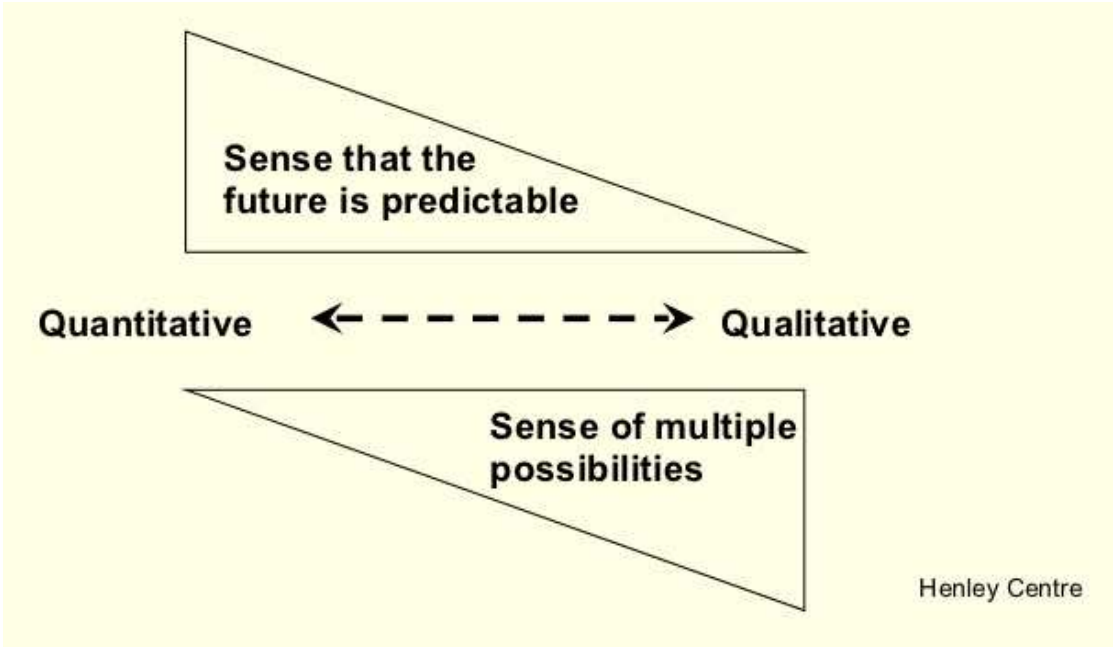
Source: Energy Modelling Forum

Cone of plausible uncertainty



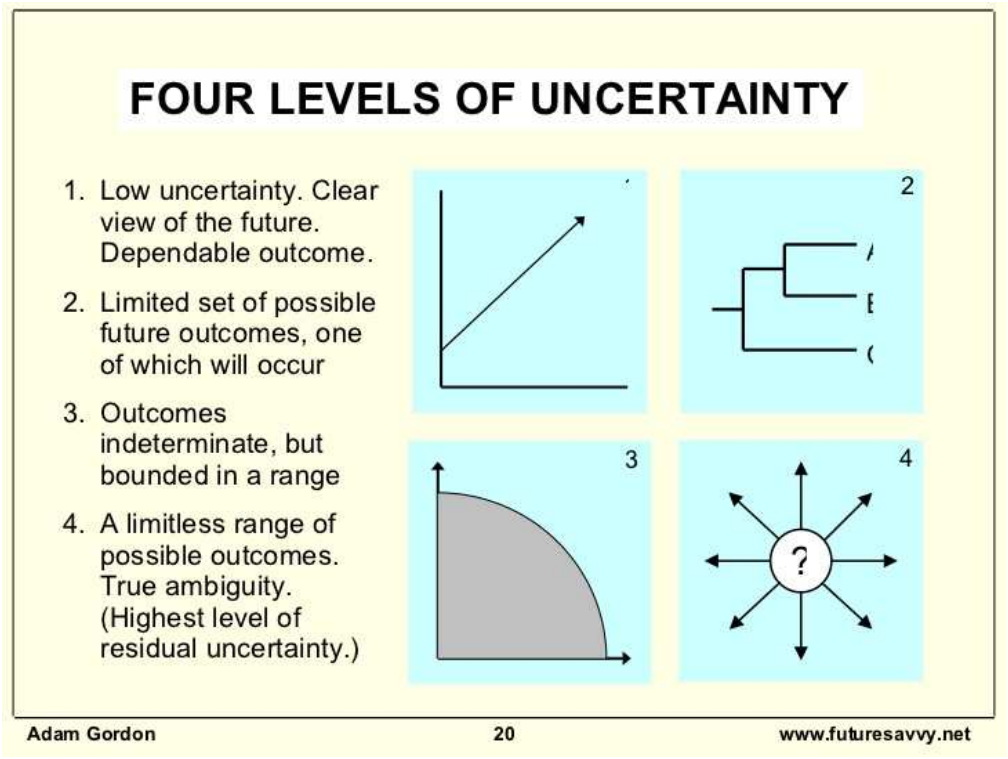
Source: www.futuresavvy.net

Sense of prediction and possibility

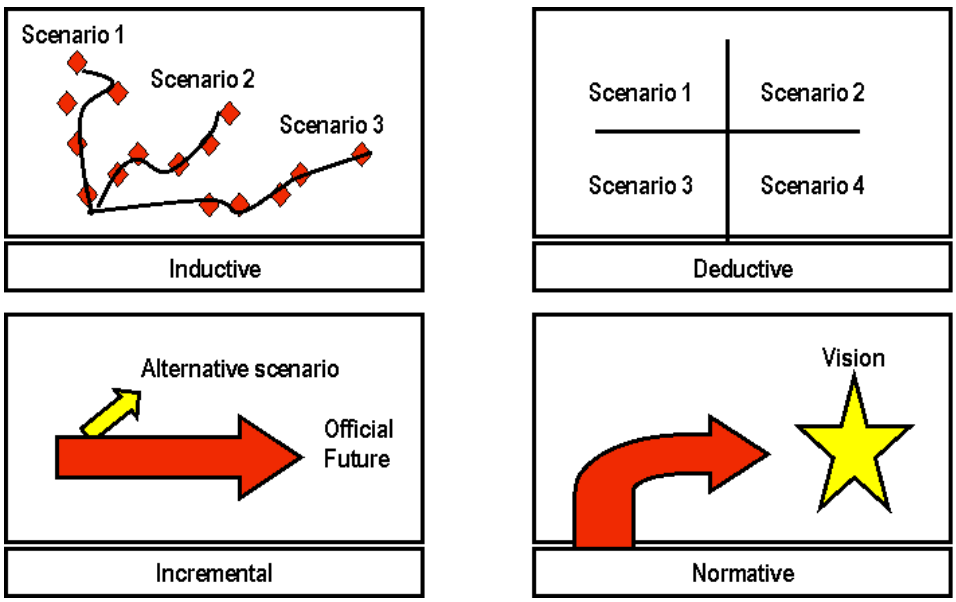


Source: www.futuresavvy.net

Level of uncertainty



Various ways to look future



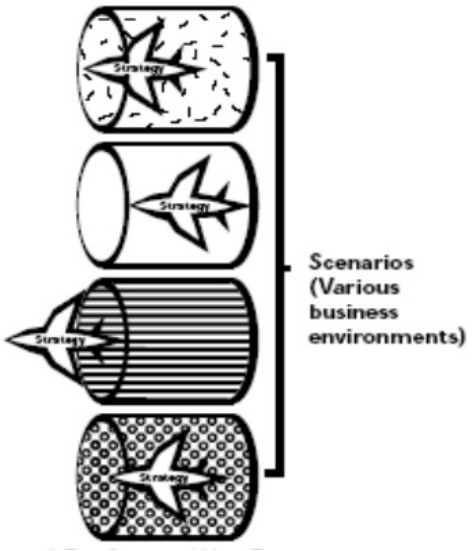
ที่มา: Ged Davis, **Scenarios as a Tool for the 21st Century**, Shell International, 2002.

Logics of “Value-neutral” and “Visionary” scenarios

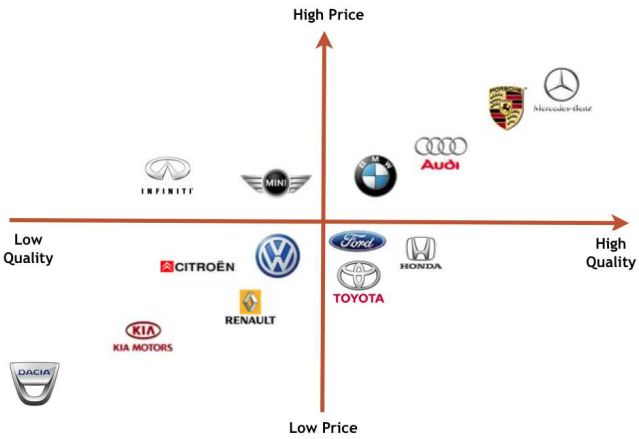
Value-neutral scenarios	Visionary scenarios
Do scanning & trend tracking. Isolate key uncertainties	Do scanning & trend tracking
Develop a scenario architecture	Listen to all needs and preferences
Consider the worlds that emerge	Find a future that we all agree on. Make this one scenario
Develop a strategy that is robust across all worlds.	Chart divergence(s) from this ideal future, incl. the present trajectory
How do we survive and profit, given what could plausibly happen?	Make strategies to bring us closer to this ideal future
	How do we make this scenario come true?

From Scenario to Strategies

Test strategy against model world



Take position in model world



LCS Vision 2030 (SIIT-TU, Kyoto University, Mizuho and etc.)

Vision A "Doraemon"	Vision B "Satsuki and Mei"
Vivid, Technology-driven	Slow, Natural-oriented
Urban/Personal	Decentralized/Community
Technology breakthrough Centralized production /recycle	Self-sufficient Produce locally, consume locally
Comfortable and Convenient	Social and Cultural Values
	

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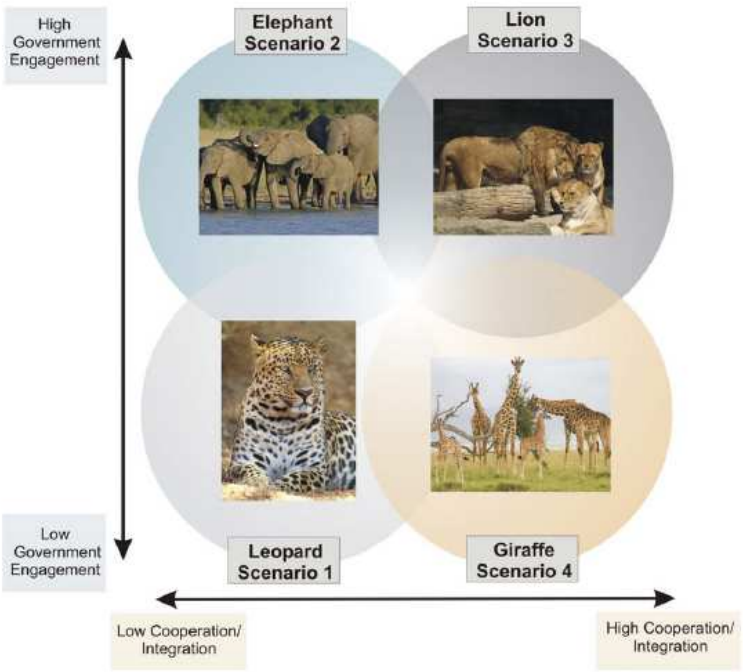
Doraemon is a Japanese comic series created by Fujiko F. Fujio. The series is about a robotic cat named Doraemon, who travels back in time from the 22nd century. He has a pocket, which connects to the fourth dimension and acts like a wormhole.

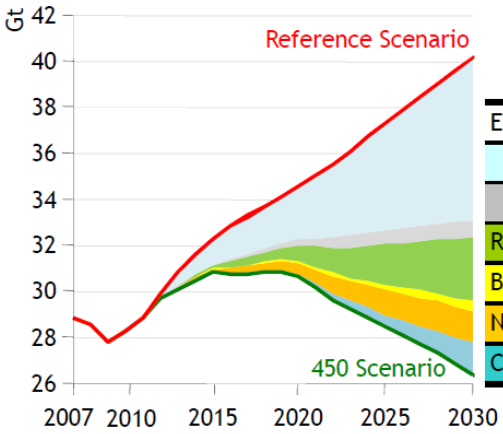
©STUDIO GHIBLI

Satsuki and Mei's House reproduced in the 2005 World Expo. Satsuki and Mei are daughters in the film "My Neighbor Totoro". They lived an old house in rural Japan, near which many curious and magical creatures inhabited.

World Energy Council 2007



World Energy Outlook



	Abatement ($Mt CO_2$)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	2 517	7 880	1 999	5 586
End-use	*2 284*	*7 145*	*1 933*	*5 551*
Power plants	*233*	*735*	*66*	*35*
Renewables	680	2 741	527	2 260
Biofuels	57	429	27	378
Nuclear	493	1 380	125	491
CCS	102	1 410	56	646

Efficiency measures account for two-thirds of the 3.8 Gt of abatement in 2020, with renewables contributing close to one-fifth

Source: International Energy Agency

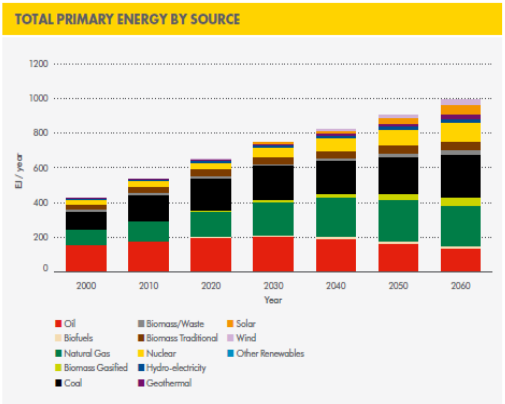
Shell scenario to 2050 (2013)

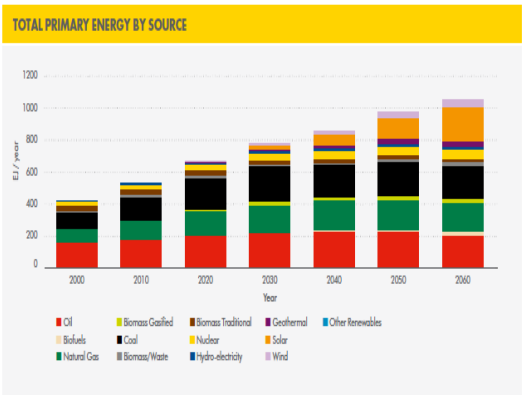
Mountain

- ภาพของโลกที่ถูกกำหนดทิศทางด้วยการควบคุม เช่น อำนาจรัฐ หรือตลาดกึ่งผูกขาด การเปลี่ยนแปลงต่างๆไม่หวือหวาและมีเสถียรภาพ ก๊าซธรรมชาติมีบทบาทมากจากการพัฒนาเทคโนโลยีและโครงสร้างพื้นฐานที่ถูกพัฒนาอย่างต่อเนื่อง

Ocean

- ภาพของโลกที่ถูกขับเคลื่อนด้วยกลไกตลาดเสรีและการแข่งขัน โครงสร้างพลังงานถูกกำหนดด้วยเทคโนโลยีที่มีความคุ้มค่า เชื้อเพลิงเหลวจะยังมีบทบาทในระยะยาวควบคู่กับก๊าซฯ พลังงานแสงอาทิตย์จะ





Source: Shell's New Lens (2013)

World energy council (2014)

Symphony	Jazz
• World where there is a voter consensus on driving environmental sustainability and energy security through corresponding practices and policies.	• World where there is a consumer focus on achieving energy access, affordability, and quality of supply with the use of best available energy sources.
• Main players are governments, public sector and private companies, NGOs, and environmentally minded voters.	• Main players are multi-national companies, banks, venture capitalists, and price-conscious consumers.
• Governments pick technology winners.	• Technologies are chosen in competitive markets.
• Selected energy sources are subsidised and incentivised by governments.	• Energy sources compete on basis of price and availability.
• Lower GDP growth due to less convergence, more environmental constraints and a more capital-intensive growth pathway	• Higher GDP growth due to faster convergence across countries, higher international competition, and low environmental constraints.
• Nationalistic strategies result in reduced exports/imports.	• Free-trade strategies lead to increased exports.
• Certain types of renewable and low-carbon energy actively promoted by governments.	• Renewable and low-carbon energy grows in line with market selection.
• Carbon market is top down based on an international agreement, with commitments and allocations.	• In the absence of international agreed commitments carbon market grows more slowly from bottom up based on regional, national and local initiatives.

Source: World Energy Coucil (2014)

Alterative future for Thailand in 2020:

Socio-Political Crisis

Nam Prick Pla Thu	Tom Yum Kung Nam Khong	Kao Lao Mai Ngok
• Self dependent economy • Traditional value • Local communities play big rule in country development	• More open to global market and influenced by external force • ASEAN regionalism • Uncompetitive firms at risk of extinction	• Civil unrest break out • Centralized power with more regulation • Traditional institution lose faith

2. Energy Modeling:

Concept & Principle of the Energy Outlook

Methodologies & Approach; Software Tools

Method of Data Collection & Analysis

Data Estimation and Assumption

Model Classification

ENERGY RESEARCH INSTITUTE

1. General and Specific Purposes of Energy Models
2. The Model Structure: Internal Assumptions & External Assumptions
3. The Analytical Approach: Top-Down vs. Bottom-Up
4. The Underlying Methodology
5. The Mathematical Approach
6. Geographical Coverage: Global, Regional, National, Local, or Project
7. Sectoral Coverage
8. The Time Horizon: Short, Medium, and Long Term
9. Data Requirements

1. General and Specific Purpose of Energy Models

General Model

- To predict or forecast the future
- To explore the future (Scenario analysis)
- To look back from the future to the present ("backcasting")

Specific Purpose

- **Energy demand model**
- **Energy supply model**
- **Impact model**

2. The Model Structure: Internal & External Assumptions

- The degree of endogenization
- The extent of the description of the non-energy sector components of the economy
- The extent of the description of energy end-uses
- The extent of the description of energy supply technologies

3. The Analytical Approach: Top-Down vs. Bottom-Up

Top-Down Models	Bottom-Up Models
use an "economic approach"	use an "engineering approach"
give pessimistic estimates on "best" performance	give optimistic estimates on "best" performance
can not explicitly represent technologies	allow for detailed description of technologies
reflect available technologies adopted by the market	reflect technical potential
the "most efficient" technologies are given by the production frontier (which is set by market behavior)	efficient technologies can lie beyond the economic production frontier suggested by market behavior
use aggregated data for predicting purposes	use disaggregated data for exploring purposes
are based on observed market behavior	are independent of observed market behavior
disregard the technically most efficient technologies available, thus underestimate potential for efficiency improvements	disregard market thresholds (hidden costs and other constraints), thus overestimate the potential for efficiency improvements
determine energy demand through aggregate economic indices (GNP, price elasticities), but vary in addressing energy supply	represent supply technologies in detail using disaggregated data, but vary in addressing energy consumption
endogenize behavioral relationships	assess costs of technological options directly
assumes there are no discontinuities in historical trends	assumes interactions between energy sector and other sectors is negligible

4. The Underlying Methodology

- Econometric models
- Macro-economic models
- Economic equilibrium models (Resource allocation models)
- Optimization model
- Simulation model
- Spreadsheet models (Tool Boxes)
- Backcasting model

5. The Mathematical Approach

- Linear Programming (LP)
- Mixed Integer Programming (MIP)
- Dynamic Programming

6. Geographical Coverage: Global, Regional, National, Local, or Project

7. Sectoral Coverage

- Single sectoral model (mostly bottom-up)
- Multi-sectoral model (interact between sectors) i.e. energy model with economic linkage

8. Time Horizon: Short, Medium and Long-term

- No standard definition
- Say 5 yrs for short-term, 3-15 yrs for medium-term, more than 10 yrs for long-term
- Different economic, social, environment are important at different time scale
- Long-run may assume economic equilibrium (resources are fully allocated, market clear)
- Short-run may incorporate transition and disequilibrium effect.

9. Data Requirement

- Long-term global and national models will necessarily need highly aggregated data with little technological detail.
- Great detail in representing energy supply and consumption is only possible in models that are specific for the energy sector

Existing Platform of Energy Model

- MARKAL -

Developers:		International Energy Agency (IEA)/ ETSAP
1. *Purposes*	*General:*	Exploring
	Specific:	Energy supply with constraints. The objective includes target-oriented integrated energy analysis and planning through a least cost approach.
2. *Assumptions:*		Low degree of endogenization, focuses only on the energy sector, detailed description of end-uses and (renewable) energy technologies possible.
3. *Top-Down vs. Bottom-Up:*		Bottum-up.
4. *Methodology:*		Toolbox/ Optimization
5. *Mathematical Approach:*		Linear programming, dynamic programming.
6. *Level:*		Local, national.
7. *Sectoral Coverage:*		Energy sector only
8. *The Time Horizon:*		Medium, long term.
9. *Data Requirements:*		Quantitative, monetary, disaggregated.

Existing Platform of Energy Model

- ENPEP -

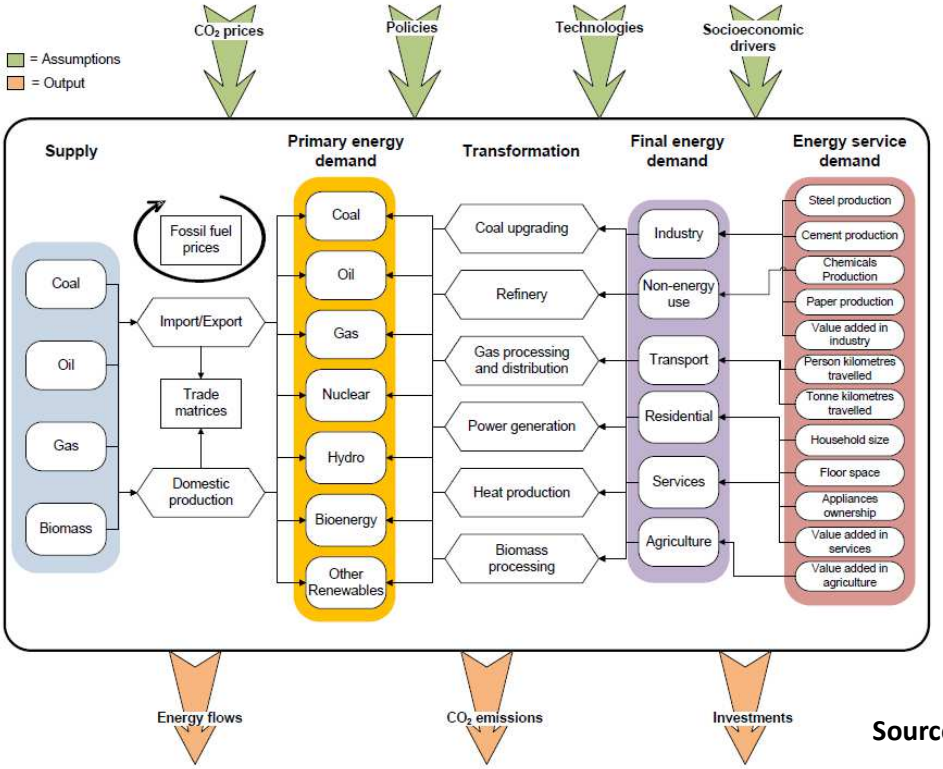
Developers:		International Atomic Energy Agency (IAEA), Autstria
1. *Purposes*		
	General:	Forecasting, exploring.
	Specific:	Energy demand, supply, matching demand and supply, environmental impacts. Detailed analysis for electricity based on least cost optimization. Integrated approach. Allows for energy policy analysis, energy tariff development, investment analysis, generation expansion planning, environmental policy analysis.
2. *Assumptions:*		Demand: high degree endogenization, description of all sectors in economy. Supply: detailed description of end-uses and (renewable) technologies.
3. *Top-Down vs. Bottom-Up:*		Hybrid. Top-down for demand analysis and bottom-up for supply.
4. *Methodology:*		Macro-economic for demand, economic equilibrium for total energy system.
5. *Mathematical Approach:*		Not available
6. *Level:*		Local, National
7. *Sectoral Coverage:*		Entire economy
8. *The Time Horizon:*		Short (1-3 yrs), medium, long (max 50 yrs).
9. *Data Requirements:*		Quantitative, monetary, aggregated and disaggregated.

Existing Platform of Energy Model

- LEAP -

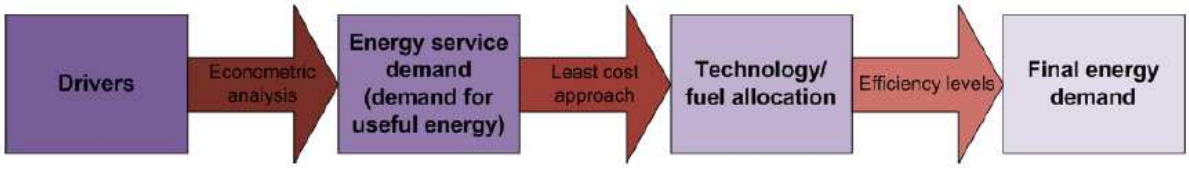
Developers:		Stockholm Environmental Institute Boston, USA
1. *Purposes*		
	General:	Exploring, forecasting
	Specific:	Demand, supply, environmental impacts. Integrated approach. the objective includes energy policy analysis, environmental policy analysis, biomass- and land-use assessment, preinvestment project analysis, integrated energy planning, full fuel cycle analysis. Applicable to industrialized as well as developing countries.
2. *Assumptions:*		Demand: rather high degree of endogenization and description of all sectors in economy Supply: simple description of end-uses and supply technologies, including some renewable.
3. *Top-Down vs. Bottom-Up:*		Demand: top-down, supply: bottom-up.
4. *Methodology:*		Demand: econometric or macro-economic. Supply: simulation
5. *Mathematical Approach:*		Not available.
6. *Level:*		Local, national, regional, global.
7. *Sectoral Coverage:*		All sectors.
8. *The Time Horizon:*		Medium, long term
9. *Data Requirements:*		Quantitative, monetary, aggregated/ disaggregated.

IEA's World Energy Model



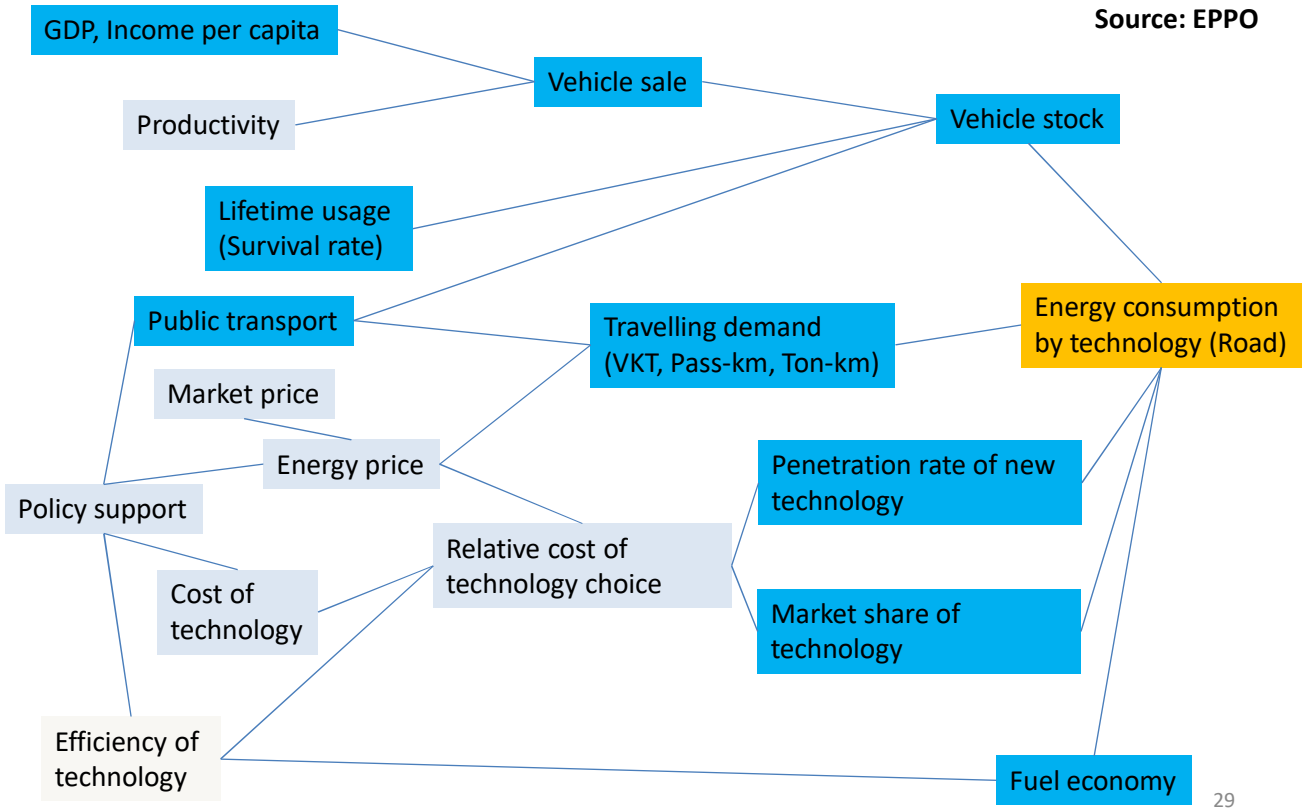
Source: WEM2015

WEM: Final Energy Demand



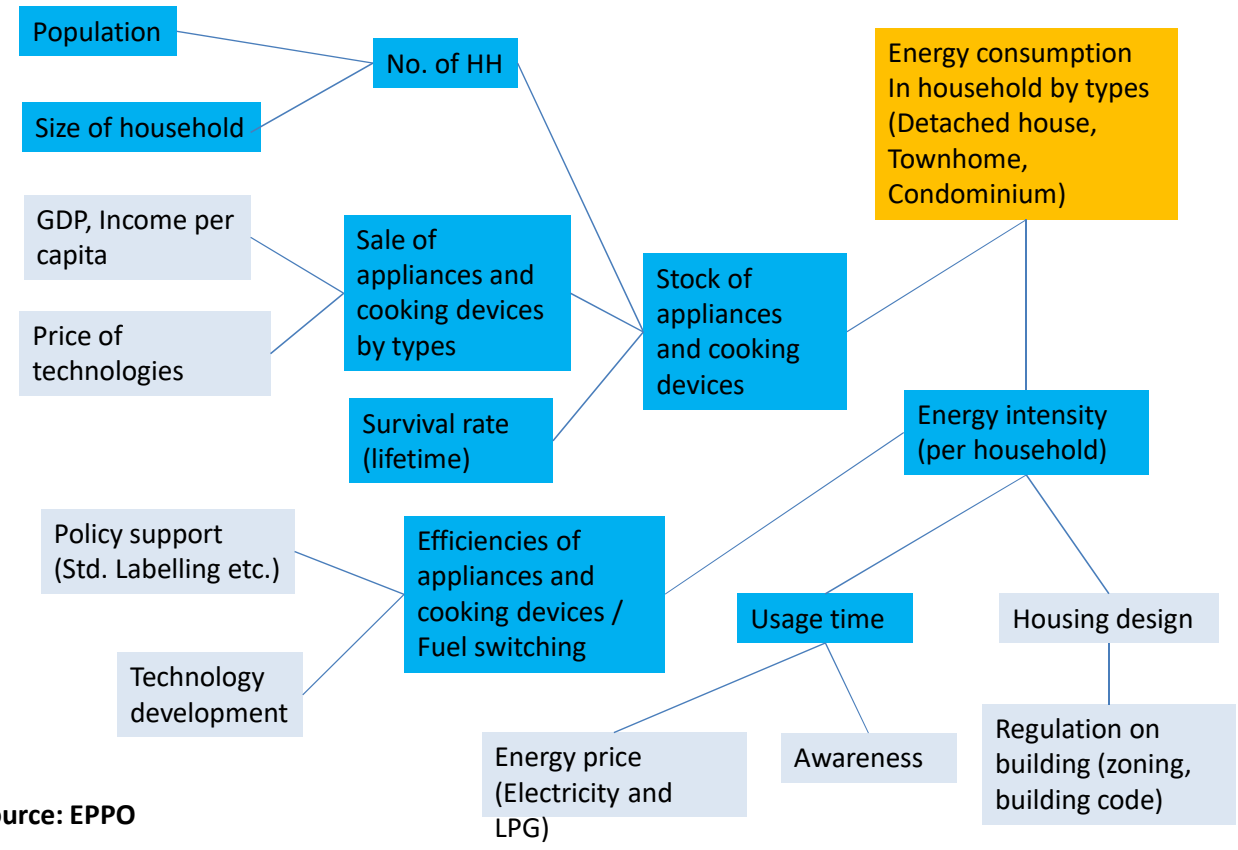
Source: WEM2015

Key drivers: Road transport



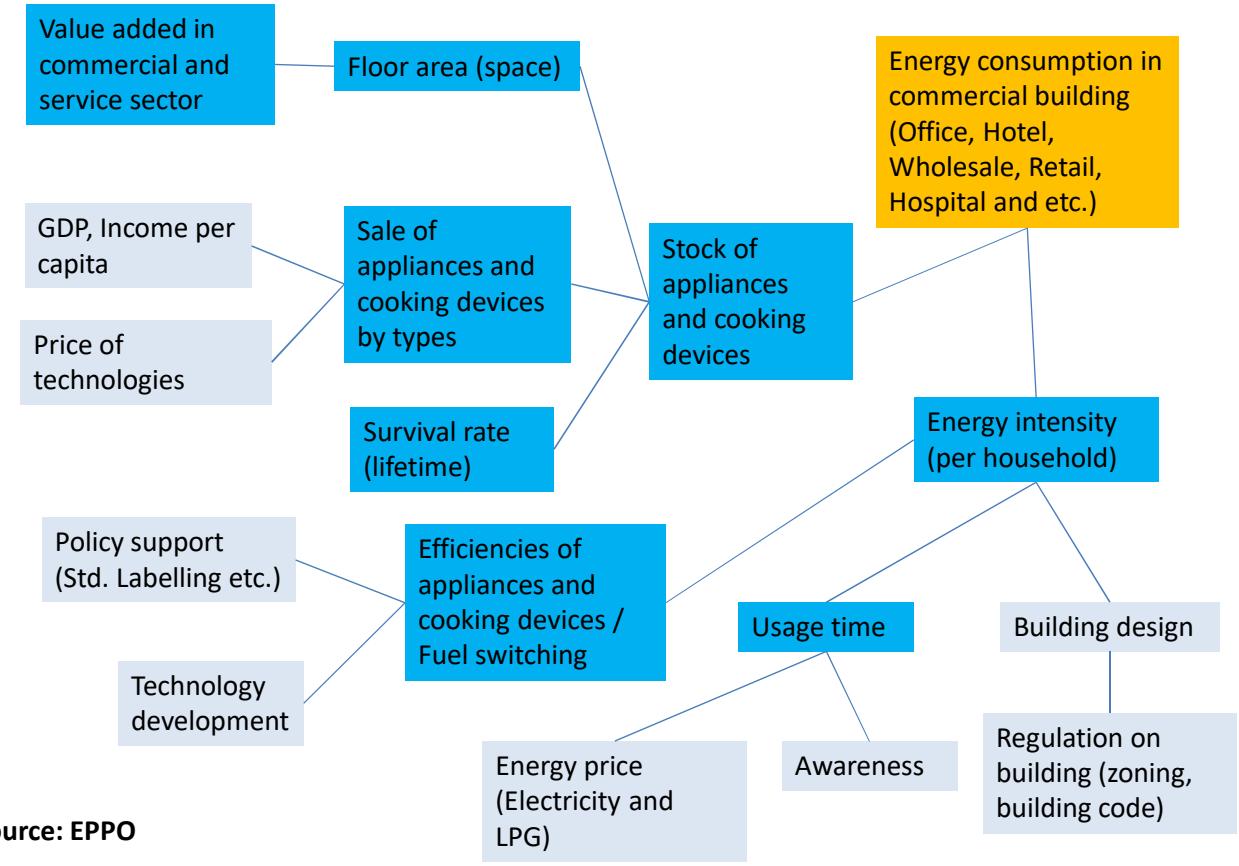
Source: EPPO

Key drivers: Residential building and housing



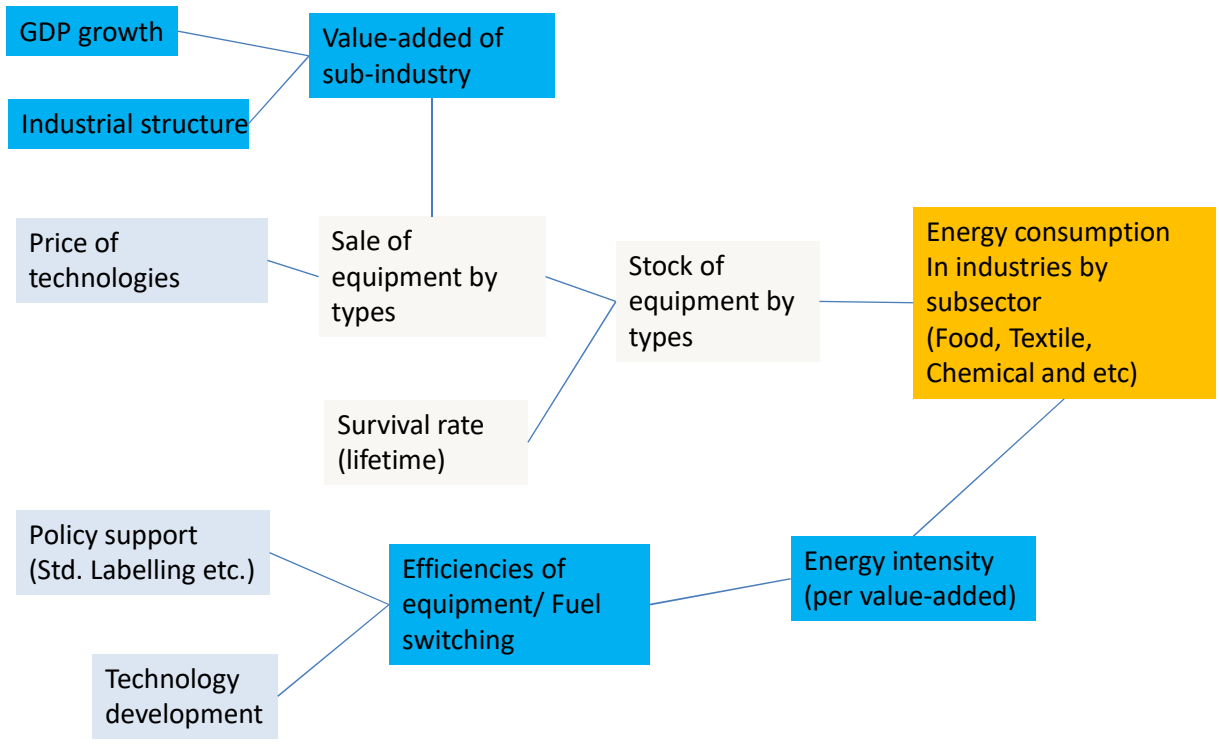
Source: EPPO

Key drivers: Commercial building



Source: EPPO

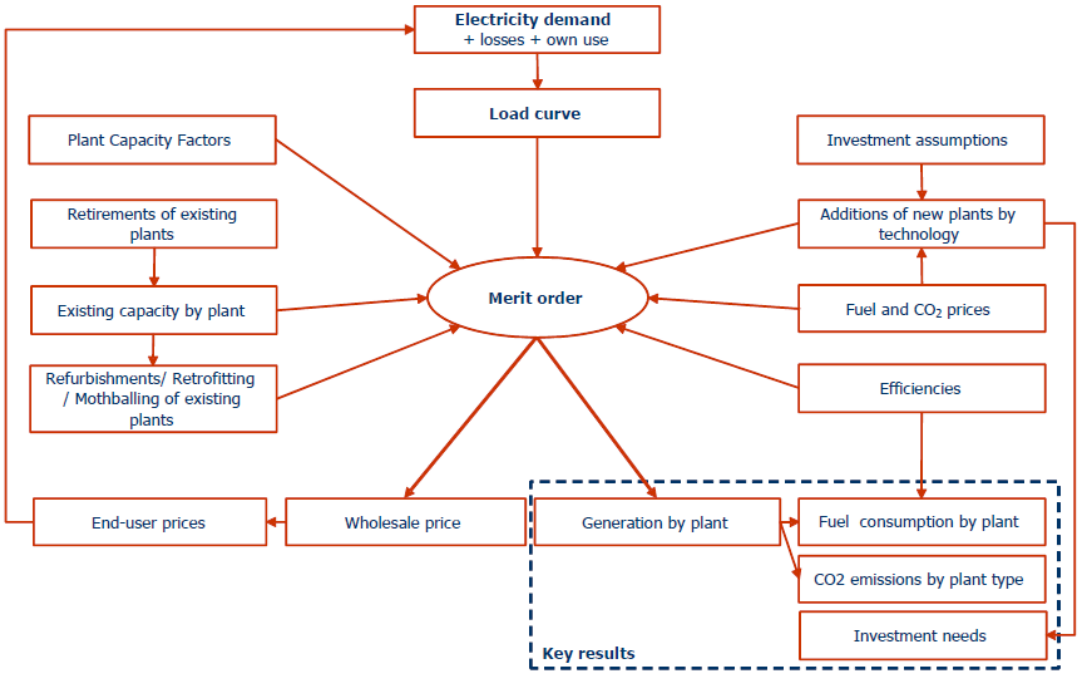
Key drivers: industrial sector



Source: EPPO

WEM: Power Generation Module

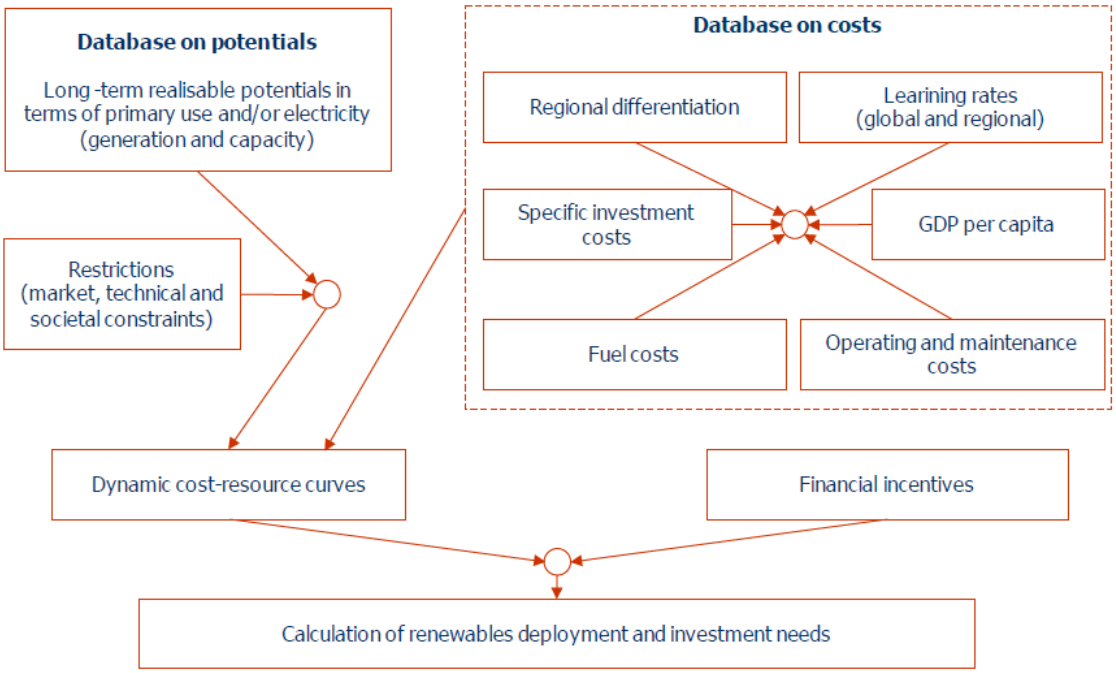
Structure of Power Generation



Source: WEM 2015

WEM: Power Generation Module

Method of approach for renewable module



Source: WEM 2015