ENERGY EFFICIENCY

IEA Caspian Energy Policy Dialogue and Training
Session 4: Saving electricity in a hurry
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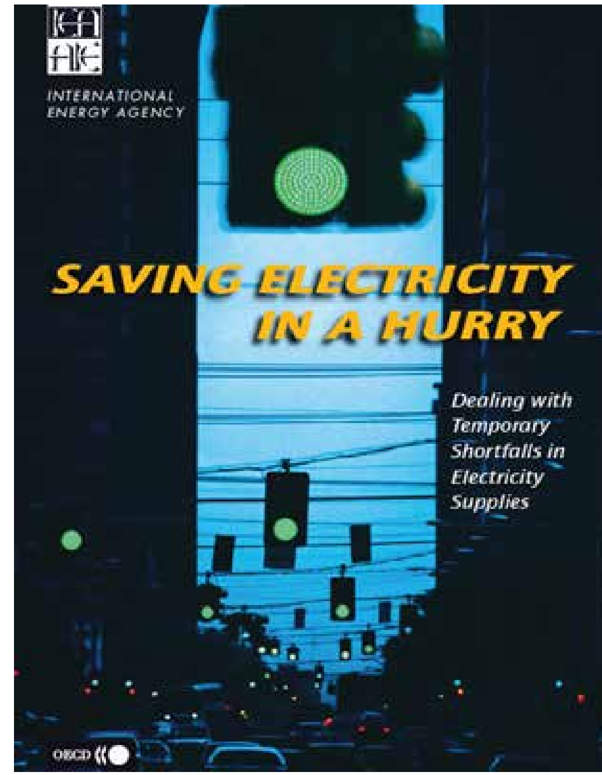
Topics

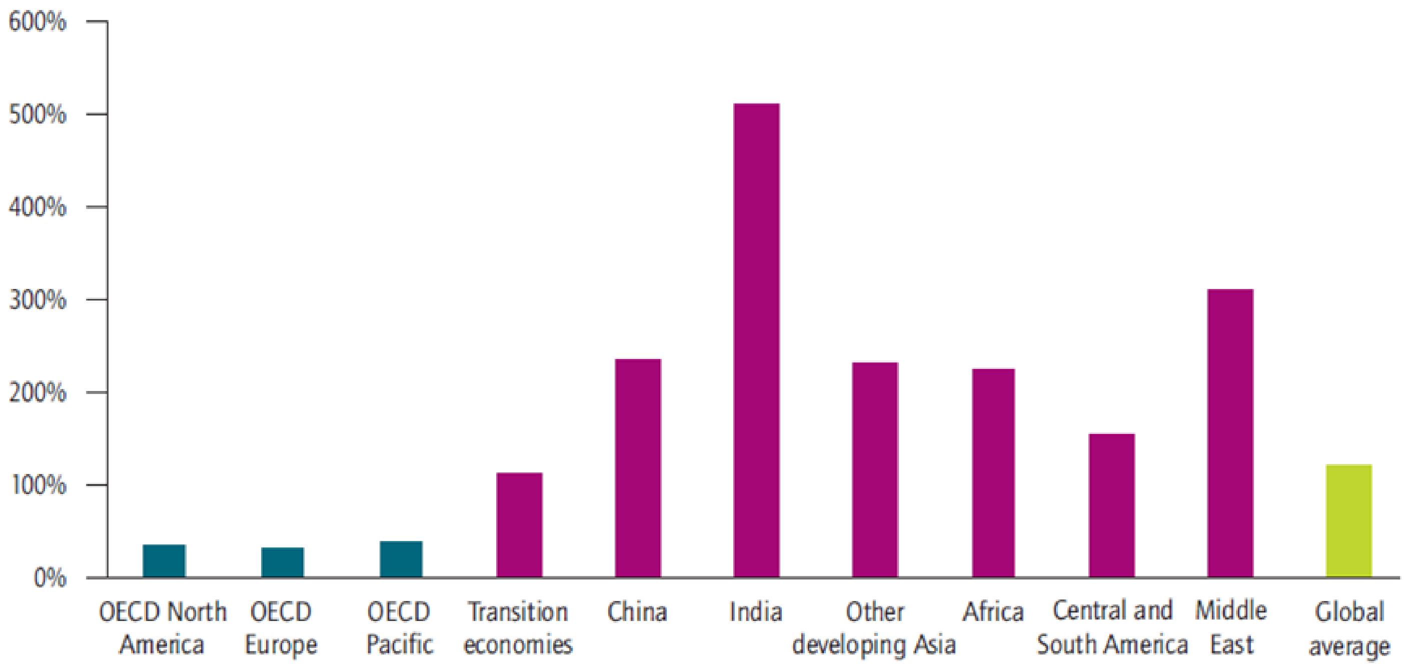
- The original *Saving Electricity in a Hurry*
- Why this message resonates today
- Developing shortfall management strategies
- Considerations from the case studies
- Recommendations for governments

The original *Saving Electricity in a Hurry*

- Based on IEA research
- Reviewed temporary but serious shortfalls in electricity supply
- Examples:
  - Brazil's 2001 power crisis
  - California's 2001 power crisis
  - Europe's 2003 long hot summer
  - New Zealand's double drought
  - Norway's 2003 dry, cold winter
  - TEPCO's 2003 nuclear shut down
- Described proven demand-side strategies for coping with shortages

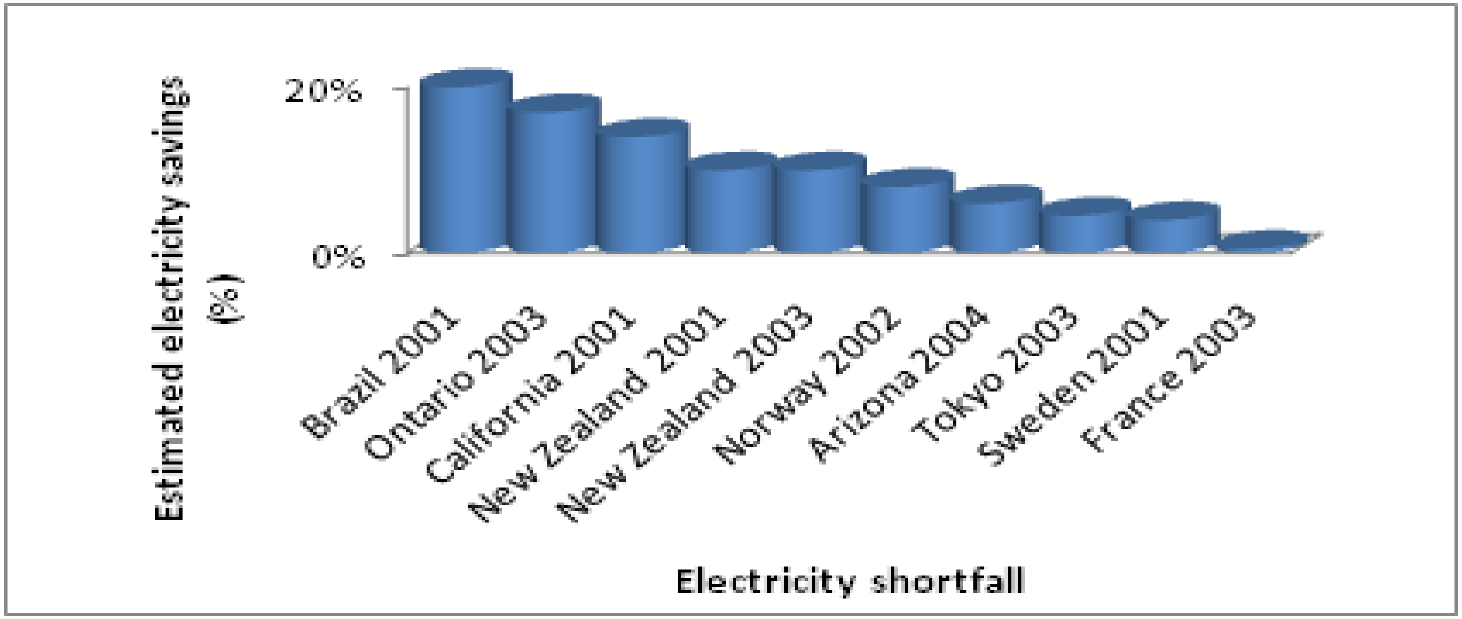


Accommodating electricity demand growth is a challenge around the globe



- Continuing and rapid Electricity demand growth
- Vulnerability to weather-induced shortfalls
- Governments and industry are hard-pressed to finance new supply
- Siting and technology choices are politically sensitive

Benefits of an electricity shortfall strategy



- Minimizes economic and social impacts
- Mobilizes support from stakeholders and civil society
- Increase awareness of the need for energy efficiency

Step-wise approach to developing a shortfall mitigation strategy

- **1. Identify possible shortfall scenarios**
  - Cause
  - Severity
  - Duration
- **2. Understand patterns of customer electricity use**
- **3. Evaluate potential energy savings measures**
  - Costs, benefits, social impacts
- **4. Put in place standby arrangements**
  - Identify lead agency
  - Authority for rationing and other measures

1. Identify possible shortfall scenarios and project their anticipated cause and duration

Timing

Duration:
1 hour – years

Advance warning:
none – years

Causation

Supply shortages
- Drought
- Interconnection or fuel interruption
- Unplanned outages or imbalances

Excess Demand
- Heat wave
- Cold wave
- Unexpected demand

Recent electricity shortfalls

Country/state	Year	Cause	Constraint
Alaska	2008	Avalanche cut transmission line	Capacity
Bangladesh	2005	Demand growth, insufficient investment	Capacity
Chile	2007/08	Drought, gas shortfall, plant breakdowns	Energy/capacity
China	2007	Drought	Energy
Ethiopia	2009/10	Demand growth, insufficient investment	Capacity
Japan	2011	Earthquake/tsunami causes plant failure	Capacity
New Zealand	2008	Drought	Energy
Pakistan	2007	Demand growth, insufficient investment	Capacity
South Africa	2008	Demand growth, insufficient investment	Capacity

Shortfalls vary according to constraints, severity, and duration

Energy Constrained Systems – lack of MWh

- Poor rainfall – Brazil, Norway, New Zealand (2001), East Africa (2006)
- Poor operations planning & reservoir management – Tanzania, Brazil
- Conflicting uses for the water: Lake Victoria, Bonneville Power Authority
- No money to buy fuel (Ethiopia)
- Curtailment in fuel supply (e.g. Chile, importing gas from Argentina)

Capacity Constrained Systems – lack of peaking MW

- Insufficient generation capacity to meet peak load (Kenya)
- Low reserve margins or susceptibility to generation outages (SA)
- Very high prices due to market manipulation or lost interconnection (California, Juneau AK)
- Unsustainable peak demand growth & low load factors (MENA countries)

Dually Constrained Systems – lack of MWh and peaking MW

- Energy constrained systems with over-depleted reservoirs (Tanzania)
- Insufficient generation capacity to meeting intermediate load (India, Pakistan)

Source: World Bank 2009

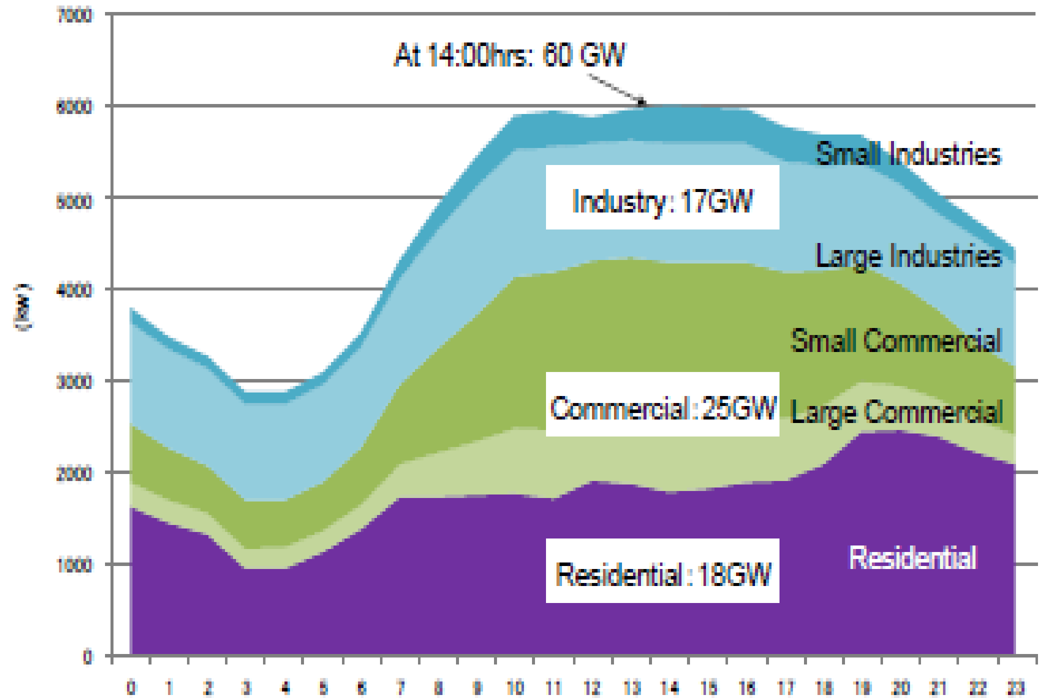
Flash survey – electricity shortfalls

- What is the main cause of shortfalls in your country?
- How often do they occur?
- What type of shortfall is typical
  - Capacity or energy?
  - Short or long duration?
- Who is responsible for managing shortfalls when they occur?

Matching demand-side measures to shortfalls

	Capacity Constraints	Energy Constraints	Capacity and Energy Constraints
Short-lived Crisis	Non-firm rates Dynamic pricing Load control	Voluntary rationing	Voluntary rationing
Long-duration Crisis	Thermal storage Load control Dynamic pricing	Mandatory rationing Fuel switching Energy efficiency Self-generation	Mandatory rationing Fuel switching Energy efficiency Self-generation

2. Understand patterns of electricity use – by sector and end-use



Source: ANRE/METI, 2011[6].

3. Evaluate energy and demand savings measures

a. Price signals

b. Information campaigns

c. Technology replacement

d. Rationing

e. Market mechanisms

a. Price signals

- Time-of-use (TOU) pricing, in which price varies according to a preset schedule, *e.g.* time of day, day of week and season.
- Real-time pricing (RTP), in which the end-user price is linked directly to hourly spot prices in a wholesale market.
- Critical-peak pricing (CPP), a hybrid of TOU and RTP in which a TOU rate is in effect all year except for a contracted number of peak days (exact dates unknown) during which electricity is charged at a higher price.

b. Information campaigns

- Analyse what consumer behaviour to change
- Identify the target group
- Choose effective communications channels
- Convey urgency while keeping an upbeat tone

c. Technology replacements

- deploying energy-efficient lighting, especially compact fluorescent lamps (CFLs) and light-emitting diodes (LED);
- replacing old equipment (ranging from refrigerators to traffic signals) with new, more-efficient technology;
- retrofitting and/or adjusting existing equipment to make it more efficient;
- installing load-control devices on selected appliances and equipment.

d. Rationing and market instruments

- Block load shedding
- Consumption rationing via quotas or entitlements
- Market-based rationing (quota and trade)
- Incentive/reward schemes (*e.g.* California's 20/20 rebate programme)

Evaluating rationing strategies

Rationing Strategies	Advantages	Disadvantages	Examples
Block load shedding	Easy to implement	Unpredictable, very inefficient, unpopular	Bangladesh California
Class-wide consumption quotas	Equitable Easy to explain and implement	Inefficient Requires "safety nets"	Brazil Japan
Market-based rationing (quota and trade)	Economically efficient Sustainable	More difficult to implement Requires strong leadership	Brazil
Incentive/reward schemes	Equitable Sustainable Encourages efficiency investment	More expensive in the short run	California
Rationing using price signals	Equitable Sustainable Reflects marginal costs Encourages investments	Bill impacts from higher rates Need to maintain a social safety net May induce load impact	Most OECD countries

Source: Heffner, et al 2009

Flash survey – demand-side management measures

- **Which of these demand side measures have been used in your country?**
- **Which do you think would have the most impact on a shortfall?**

The cases

	Japan 2011	Juneau 2008	New Zealand 2008	South Africa 2008/09	Chile 2007/08
Energy savings	15% for most sectors	25% to 40%	3.6% to 6.7% for households	20%, primarily for industry	No demand growth
Duration	Since March 2011	6 weeks	June-July 2008	January 2008-2009	Several months
Electricity shortage management measures					
Price increases		X	X (industry)	X	X
Information campaigns	X	X	X	X	X
Technology replacement	X	X (CFLs only)	X	X	X
Rationing	X	X		X	X
Market mechanisms			X	X	

2011 Japan earthquake & tsunami

- **15-25 GW of TEPCO's total 70 GW capacity knocked out of service from the March 11 earthquake and tsunami**
- **9 days of black-outs caused confusion and hardship**
- **Transport, hospitals, businesses hit hard**
- **Emergency Response entity (Electricity Supply Demand Emergency Response Headquarters) developed plans for the summer peak period**
- **Energy savings measures:**
  - **Multi-media awareness-building campaign**
  - **Mandatory rationing of 15% for industry**
  - **Super Coolbiz programme**
  - **Energy savings advice to small and medium enterprises**
- **Japanese community spirit and innovation in gear**
- ***Most consumers are ready to respond to a crisis. They just need some guidance to contribute.***

Japanese energy saving innovation

Web site for households to check energy use

Household Power Saving Menu *Agency of Natural Resources & Energy*

Check the actions below and prepare measures of your household.

		Reduction Rate	Power Reduction
A/C	① Set room temperature at 28°C.	10%	130W
	※When setting the temperature by 2°C.		
	② Use "sudare" or "yoshizu" (Japanese shades made of rattan and reed) to decrease sun exposure.	10%	120W
	③ Turn off A/C and use electric fan.	50%	600W
	※ Avoid Dry mode operation and frequent switching on/off as they increase power usage.		
Refrigerator	④ Change the refrigerator temperature setting from powerful to medium, minimise opening doors and limit amount of food kept inside.	2%	25W
Lighting	⑤ Turn off lights during the day and reduce lighting in the evening.	5%	60W
T V	⑥ Use energy savings mode, decrease brightness, and switch off when not in use.	2%	25W
	※Change mode from "standard" to "energy saving" mode and reduce hours of watching by 1/3.		
Toilet heater /warm shower	⑦ Switch off seat-heating & hot-water functions. (Reduction by either one of the two)	>1%	5W
Rice cooker/jar	⑧ Cook rice for the day and store it in the refrigerator rather than keeping it warm in the rice cooker.	2%	25W
Standby Power	⑨ Unplug unused appliances.	2%	25W

Apply ④⑦⑧&⑩ measures even when you are away from home.

Save power by more than 15% (sum of power reductions) % W

! Beware of heat stroke. Save power with flexibility and comfort.

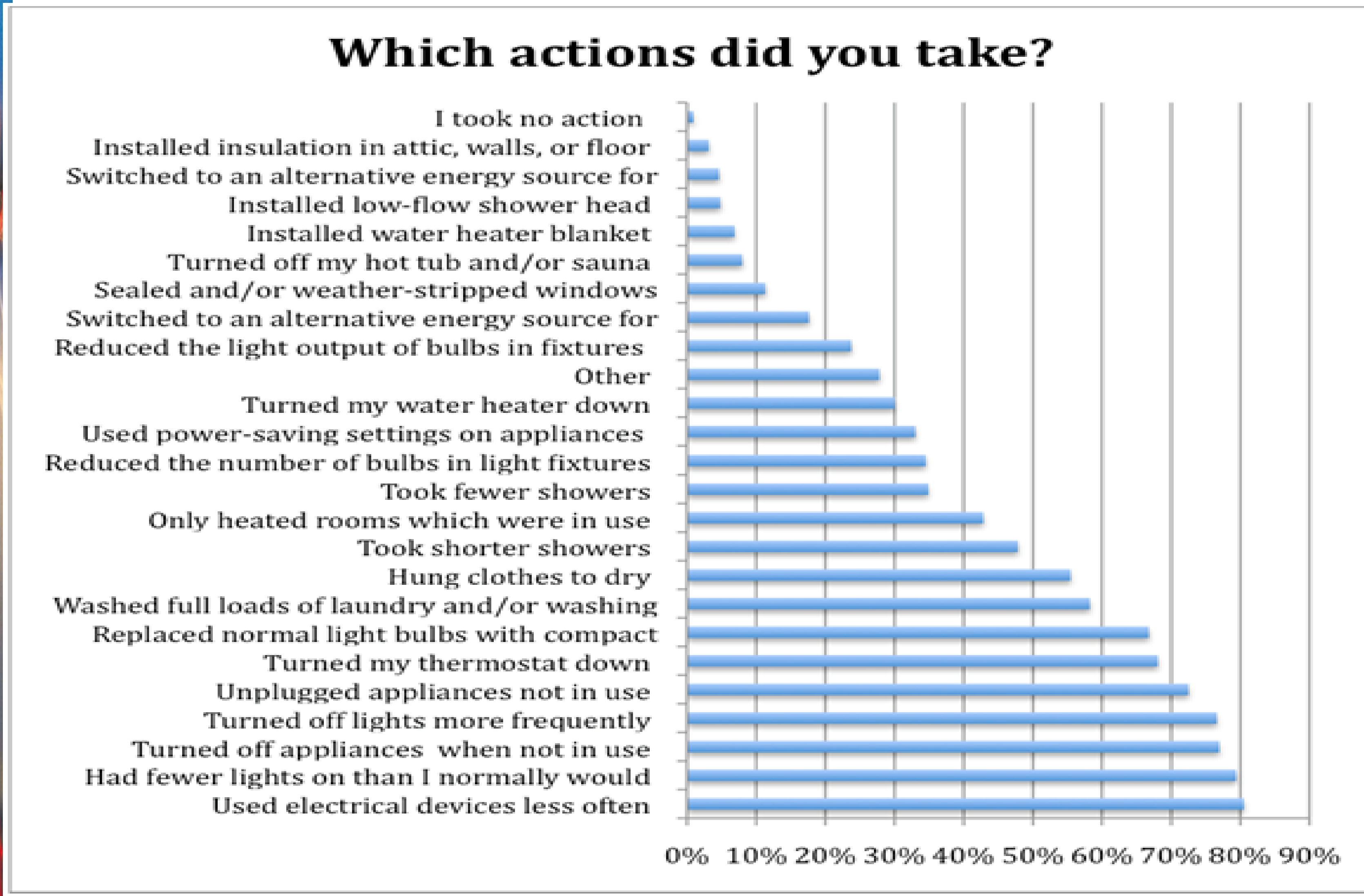
※Numbers listed for power saving effect are estimated as reduced power consumption and their % changes from the average daytime power consumption of about 1200W at 14:00 when family member(s) is(are) at home (ANRE estimation).

Super Cool Biz Summer 2011 office fashion ideas

Juneau Alaska

- **Small, isolated community**
- **Electricity shortfall by avalanche brought on a quick response**
- ***Juneau Unplugged* campaign reduced demand by 40%**
- **Fuel switching provided the most savings**
- **An NGO proved effective in mobilizing the community**

What a little behaviour change can do



South Africa 2008: a familiar opening gambit to an electricity shortfall

- Chronic underinvestment in new capacity plus demand growth combine to degraded reserve margins and create power system vulnerability
- Unusual weather and fuel/plant availability conditions combine to create a crisis
- System operators resort to load shedding to prevent system collapse, which in turn creates economic, social, and political convulsions

Getting it right: Power Conservation Program

- PCP as a social contract with electricity users
- Creation of a PCP coordination committee
- Looking at electricity shortfall approaches used elsewhere
- Settling on the 10% energy savings target for all sectors
- Phasing-in rationing, beginning with the largest users
- Back-up plans to extend rationing if needed
- Communications activities
  - Power Alert scheme for households
  - 49 million households
- Other initiatives:
  - Solar water heater initiative
  - Smart metering trials
  - Eskom’s DSM program - 5000 MW over 20 years

Example of a DR strategy: South Africa

	RATIONING	ENERGY EFFICIENCY	DEMAND SIDE PARTICIPATION
Approach	"Quasi-Market Based Rationing"	Standard Offer	Demand Response—Reliability (and possibly Economic)
Product	MWh and indirectly MW reduced	MWh and indirectly MW reduced	MW (capacity) reduced in different timeframes. Negligible on MWh
Primary Target Market	All customers at the outset	Medium and large. Smaller with "aggregators"	Primary large
Incentives	Bonuses, penalties, disconnection, differentiated quotas per customers group	Fund to subsidy. Difference between price paid and regulated tariff (per kWh). Differentiated by technology	Pecuniary incentives for reliabilty. Differentiated by speed response.
Safety Net for the Poor	No Quotas, only bonuses	Programs targeting poor customers (e.g. efficient appliances)	Not applicable
Speed of Implementation and load response	Very short term	Medium and long term	Short term
Permanence Factor	Medium term for conservation, long term for energy efficiency	Long Term for energy efficiency	Duration of program

Source: The World Bank

New Zealand

- Hydro-dominated systems are prone to shortfalls
- Wholesale markets prices deliver scarcity pricing mostly for larger users
- Repetitive shortfalls call for mechanisms that reward energy saving consumers
- Triggers are useful. They provide advance notice of a shortfall –before the blackouts come

What's the problem?

- NZ electricity system is 70% hydro with limited (40 day) river system storage and considerable inertia in annual snow melt.
- Hydrological inflows fluctuate significantly with the pacific ocean weather patterns:
  - Southern Pacific Oscillation, 10 year cycle
  - La Nina - El Nino, 3 year cycles
  - Chaotic as well as complex
- Some transmission constraints: 11000km, 178 GXP system, 350Vdc 700MVA link from lakes in South to load centers in North.
- Sometimes things go wrong

Large industrial customers

- Pricing: industrial users carry both hedge and spot contracts according to load type and are incentivised to respond.
- Get half hourly spot price signals that they analyse against prevailing business environment and make operational decisions in short run;
  - Reduce / alternate output
  - Shed load
  - Use alternative generation, fuel switching...
- In the long run;
  - Energy efficiency decisions, alternative energy sources, plant upgrades, etc

What about residential and small commercial consumers?

- Sect 42 of the Electricity Act requires:
- Pricing; Customer Compensation Scheme (March 2011)
- Households get NZD10.50 per week during a Public Conservation Campaign (PCC)
- Based on estimated value of consumer conservation.
- PCC initiated by System Operator (Transpower) when risk is >10% for more than 1 week.

What are the smart network companies doing? Orion Networks NZ

- 20+ years of effective demand response pricing, avoiding investment in new transmission.
- Pricing; Major customers face control period demand prices for 80-100 hrs during three winter months
- Developed EE, LPG, and tech solutions
- Lowest cost provider of network services in NZ
  - Asset Management Plan
  - Network Quality Report
  - Load Management Dashboard
- www.Orion.co.nz/load management

Electricity Efficiency Programmes supplement market policies

- **Lighting – residential and commercial**
- **Electric motors and drives**
- **Heated towel rails**
- **Compressed air**
- **Funded by levy on all electricity sales**
- **$11M/yr scheme funds projects with c/kWh saved costs below LRMC of generation**
- **www.eeca.govt.nz**

System Management

- System Operator, Emergency Management Policy www.systemoperator.co.nz
- Managing Security of supply risks 2011
- Stress test regime 2011
- Review of 2008 Winter
- Buy-back consultation document 2008
- Annual Security Assessment 2007
- 2007 Reserves Assessment
- Proposal for rolling outage regulations and planning 2006
- Security of Supply Policy Development 2004

all at www.ea.govt.nz/search

Key Features

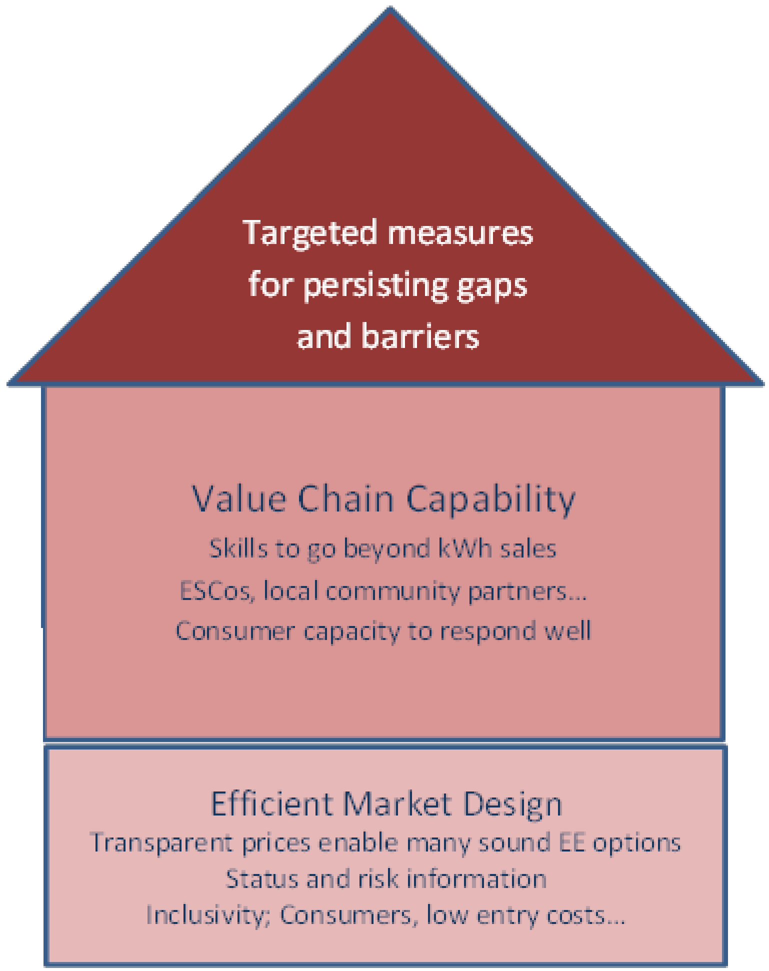
- Key players in the market (the regulator, generators, transmission, distribution, retailers and large users) all have response plans and strategies in place before the event;
- A clear understanding of “when is this a problem”, the emergency zone definitions provided real clarity that all can understand;
- A market which enable rational responses from users by sending ‘’appropriate’’ price signals
- Information which enables robust decisions including hydro reserve and output data for all to understand;
- Consultation and co-operation between government, regulator, suppliers and users enabled industry led initiatives.

So what have we learned on the way?

- **When you identify that you have a supply problem – its too late; *ad hoc responses are more disruptive and ineffective than necessary***
- **Setting up the electricity system to reflect supply risks by information and price is key to stimulating efficient innovative responses and rewarding economically efficient demand responses**
- **If you accept that 'things can go wrong' and have dynamic market signals; *supply and demand side players innovate a range of cost effective and more durable options***
- ***Increased responsiveness supports other policies; minimum prices, increasing renewables, ETS***
- ***Need to continue learning, reviewing, reporting.***

Concept Model for Effective Security and Energy Efficiency in Electricity Systems

Grants
Obligations
Programmes
Certificates
Tax policy
Regulations...



Market rules
Disclosure information
Obligations
Tariffs….

Electricity efficiency projects; motors, comp air, lighting…

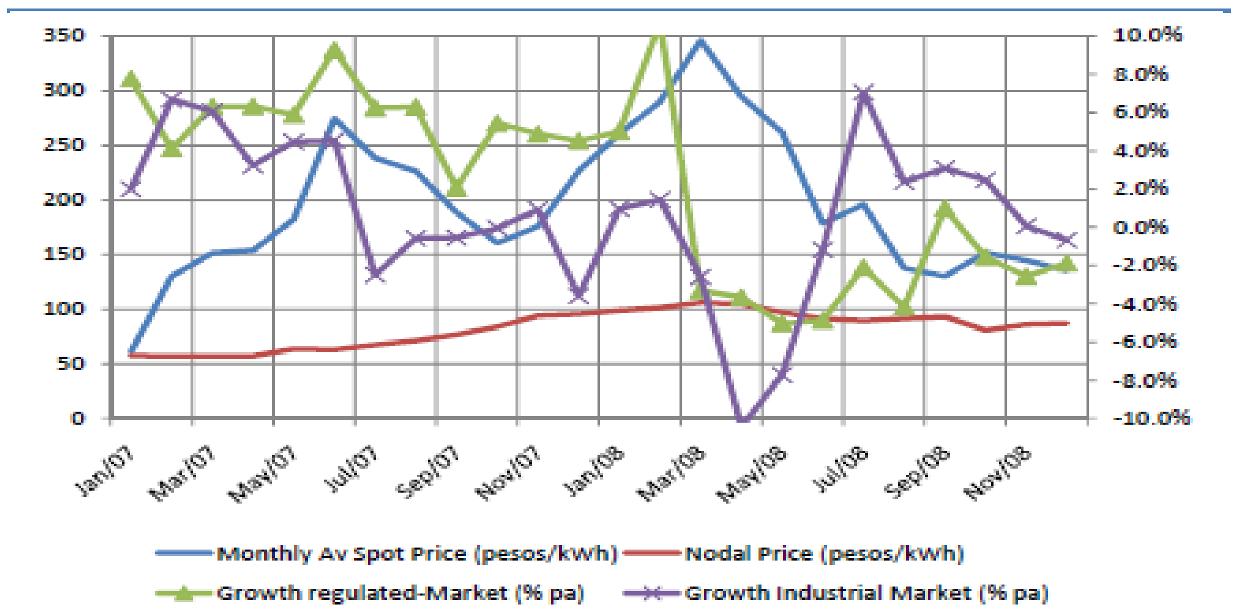
Escos,
Best practice programmes,
Training,

System risk analysis
Options analysis
System operator response rules
Information for all

Summing up….

- Successive dry year crises have compelled government to ensure that:
  - the NZ electricity market is set up to send clear price signals and system information to reflect supply risk
  - Market participants are enabled to manage this risk and develop many innovative responses
  - Consumers can receive market intelligence as well as spot price signals to encourage timely action
  - Everyone, including consumers, learns to weigh up costs and benefits of a range of cost effective lead shedding, EE, and alternative supply options

Chile – price is not enough



Source: Adapted from original data provided by CNE.

• Wholesale markets do work to dampen demand, but will not do the job alone
• Existing energy efficiency programmes can be scaled-up to delivery savings in a hurry
•Take special care of vulnerable customer groups

Key messages from the case studies

Case study	Key message
Japan	Most consumers are ready to respond to a crisis. They just need a little guidance in order to quickly contribute
Juneau, Alaska	Establishing a new, neutral entity (not government or industry) can help mobilize community response
New Zealand	Shortfall-prone countries should put in place pricing and other mechanisms to mitigate shortfalls
South Africa	Don’t rely on a single sector – need to mobilize all consumers
Chile	Plan ahead through collecting good data.

Discussion – do these case studies apply to your region? Why or why not?

Recommendations for Governments and Regulators

- Evaluate whether your power sector is exposed to electricity shortfalls, and if so make contingency plans
- Designate responsibility for planning and implementing shortfall management strategies
- Make sure energy providers collect data on electricity usage patterns, to identify energy savings measures
- Consider the full range of energy savings measures in any electricity shortfall strategy
- Anticipate and resolves any regulatory or other barriers to your energy savings measures
- Clearly articulate a trigger point that defines when a shortfall is imminent, and when shortfall management should commence

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Questions?

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