
Distributed Generation Resources: Promise and Potential

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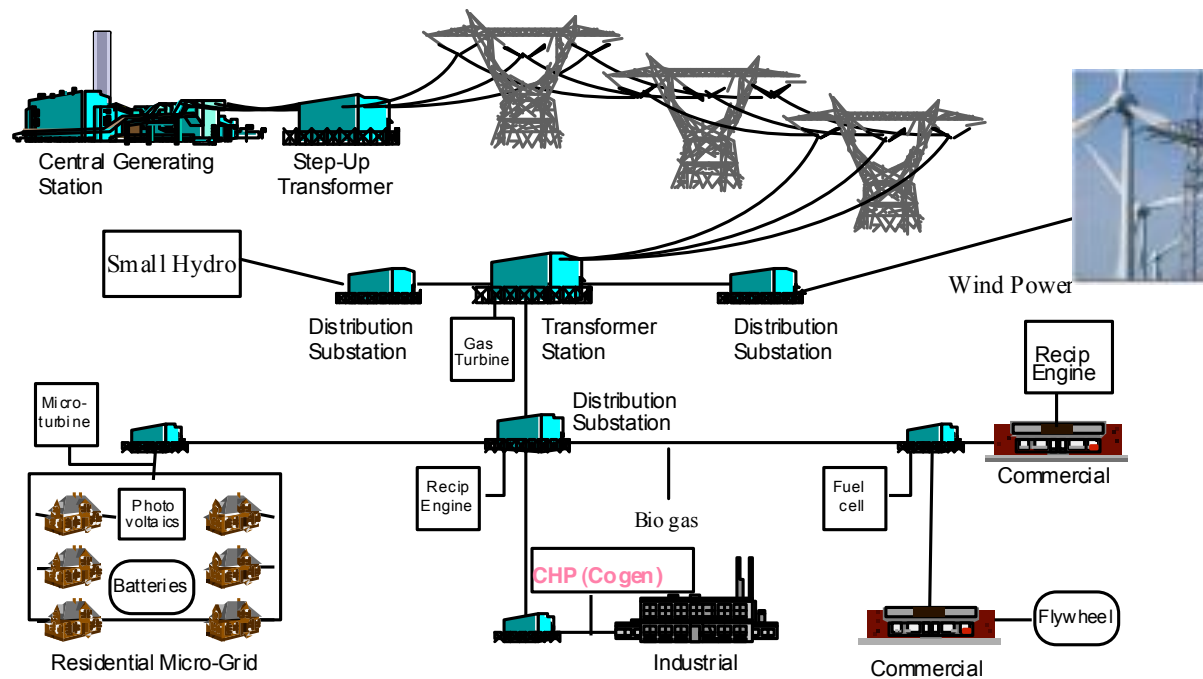
Distributed Generation: Vision

- Abundant, secure, clean, flexible and reliable energy resource
- Fuel cells in every basement; micro-CHPs in every kitchen and PVs on every roof
- Industrial facilities generating own power & utilizing waste heat
- Retail malls/community centres as self-sustaining (“microgrids”)
- Reliability and outages become non issues
- Storage for intermittency & “on-peak/off peak” arbitrage
- Cars and trucks powered by electrons and or/ hydrogen
- Large scale centralized electricity generation?
- Bulk power transmission?

Distributed Generation: Reality

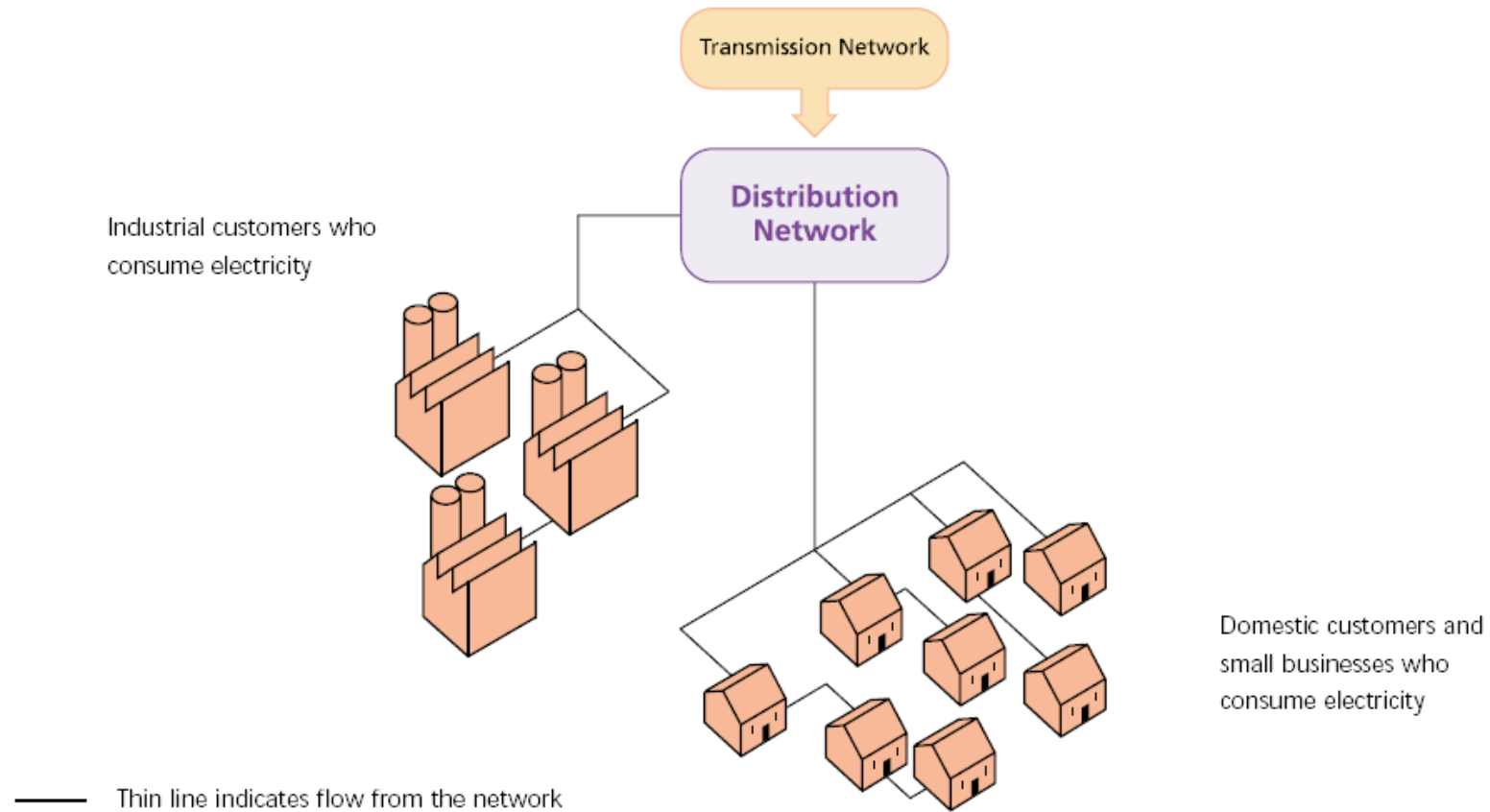
- Performance has not equaled promise
- Fuel cells, microturbines, photovoltaics - still too expensive
- Fundamental business case?
 - Availability of “cheap” natural gas?
- Institutional Barriers?
 - case by case connections approvals- problematic
- Transmission and Distribution
 - Capital deferral, utilization, congestion....

Emerging new supply within an integrated power network



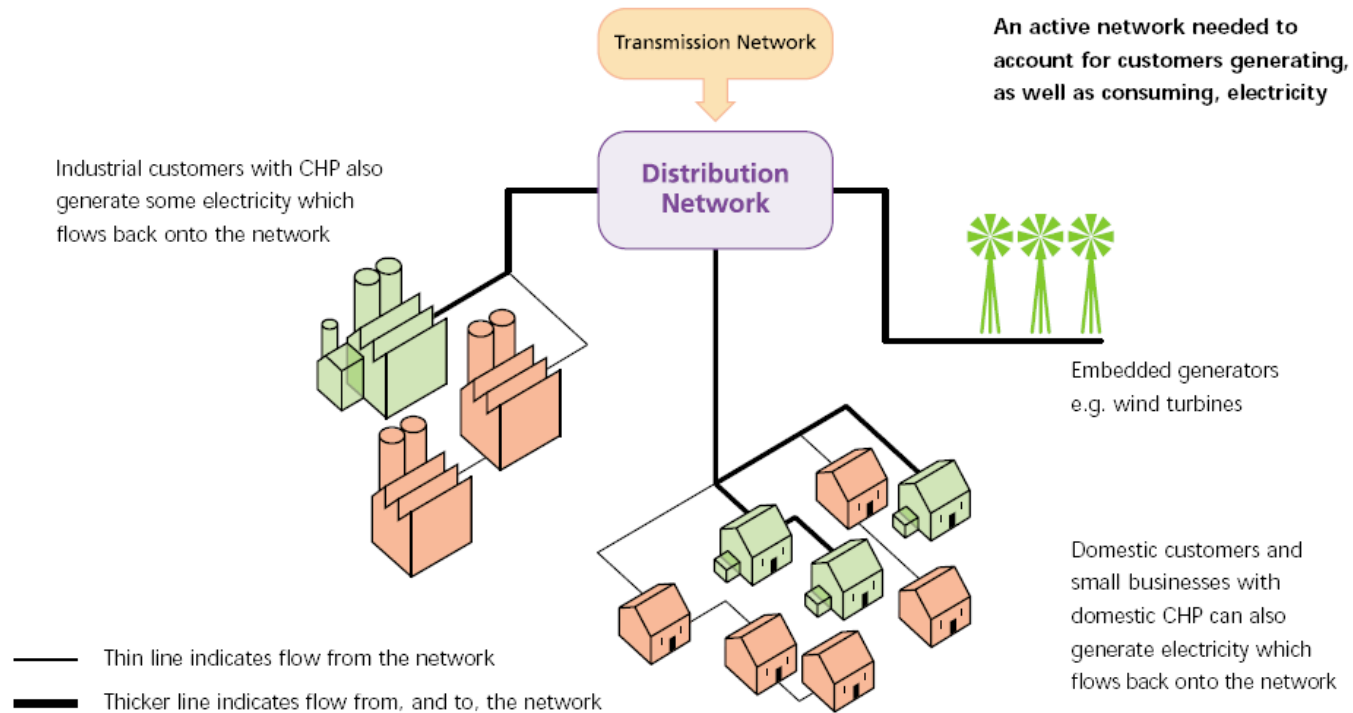
Power flows one way: network to the customer

Distribution network – conventional



Paradigm shift: Power flows both ways

Distribution network – with distributed generation

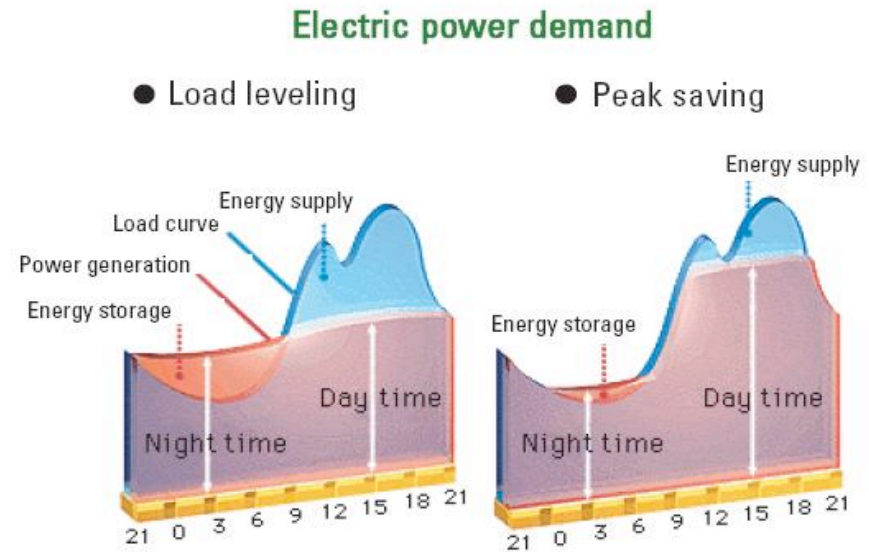


DG Technologies and Characteristics

- Wind power (small projects with outputs from 50kW to 10MW)
- Biogas and biomass (landfill sites, agricultural and livestock operations, wood forest residues, wastewater treatment facilities:1-10MW)
- Combined Heat and Power (CHP) schemes including micro-CHP (residential 1kW-25 kW) and Stirling engines (1kW to 55kW)
- Solar photo-voltaic (PV) cells (50kW- 1MW)
- Fuel cells (1kW to 1MW)
- Microturbines (20-100kW)
- Natural Gas reciprocating engines (30kW- 3MW) and dual fuel reciprocating engines (90kW- 2MW)
- Gas and diesel fired combustion turbines (>1MW)
- Large DG applications & mobile systems for standby generation
 - (0.5 to 2MW),
 - peaking (1-5MW)
 - T&D support (0.5-10MW modules) and crisis operations

Distributed Energy Resources- Energy Storage

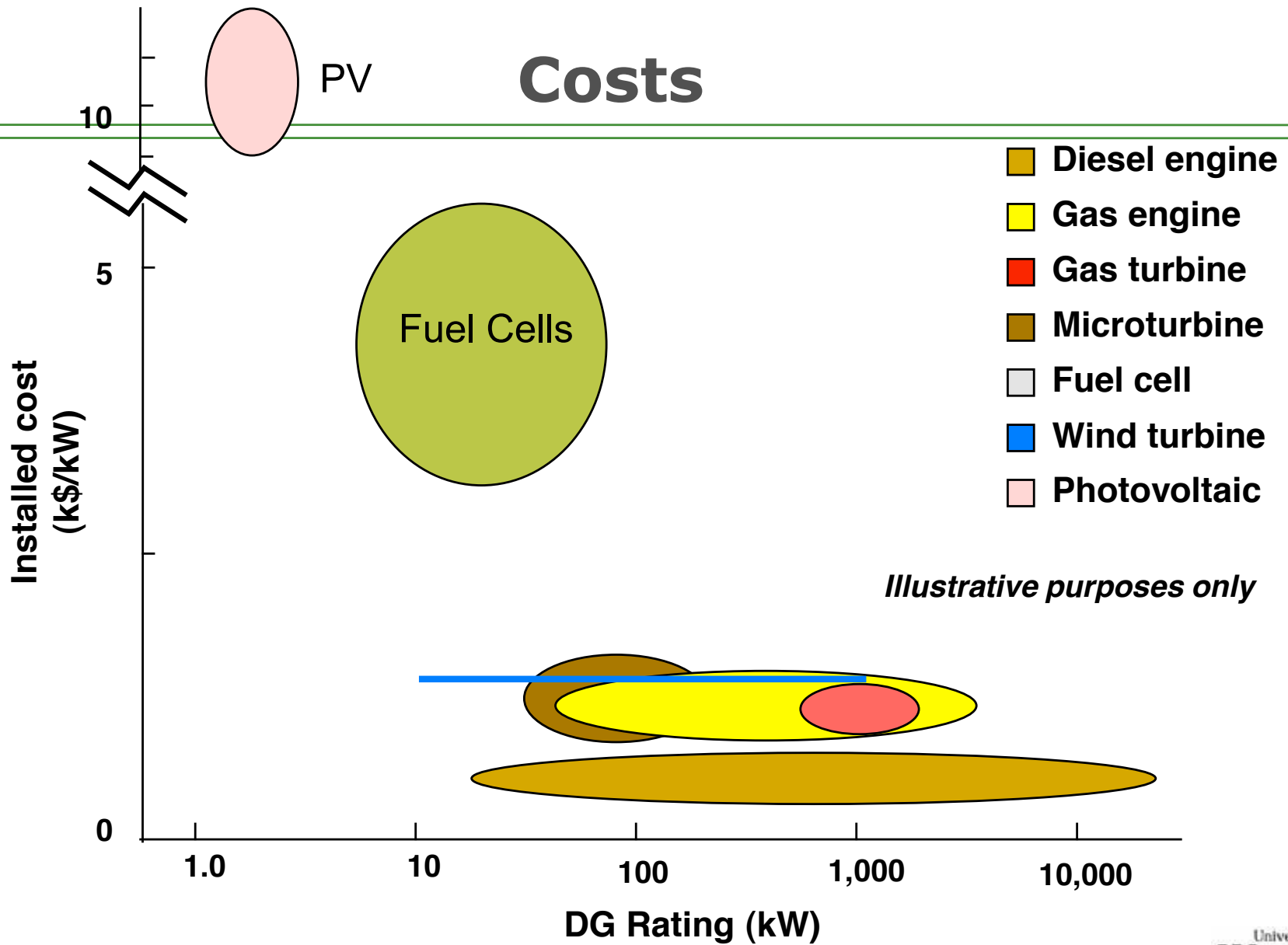
- Electricity storage: Competitive or complementary to DG



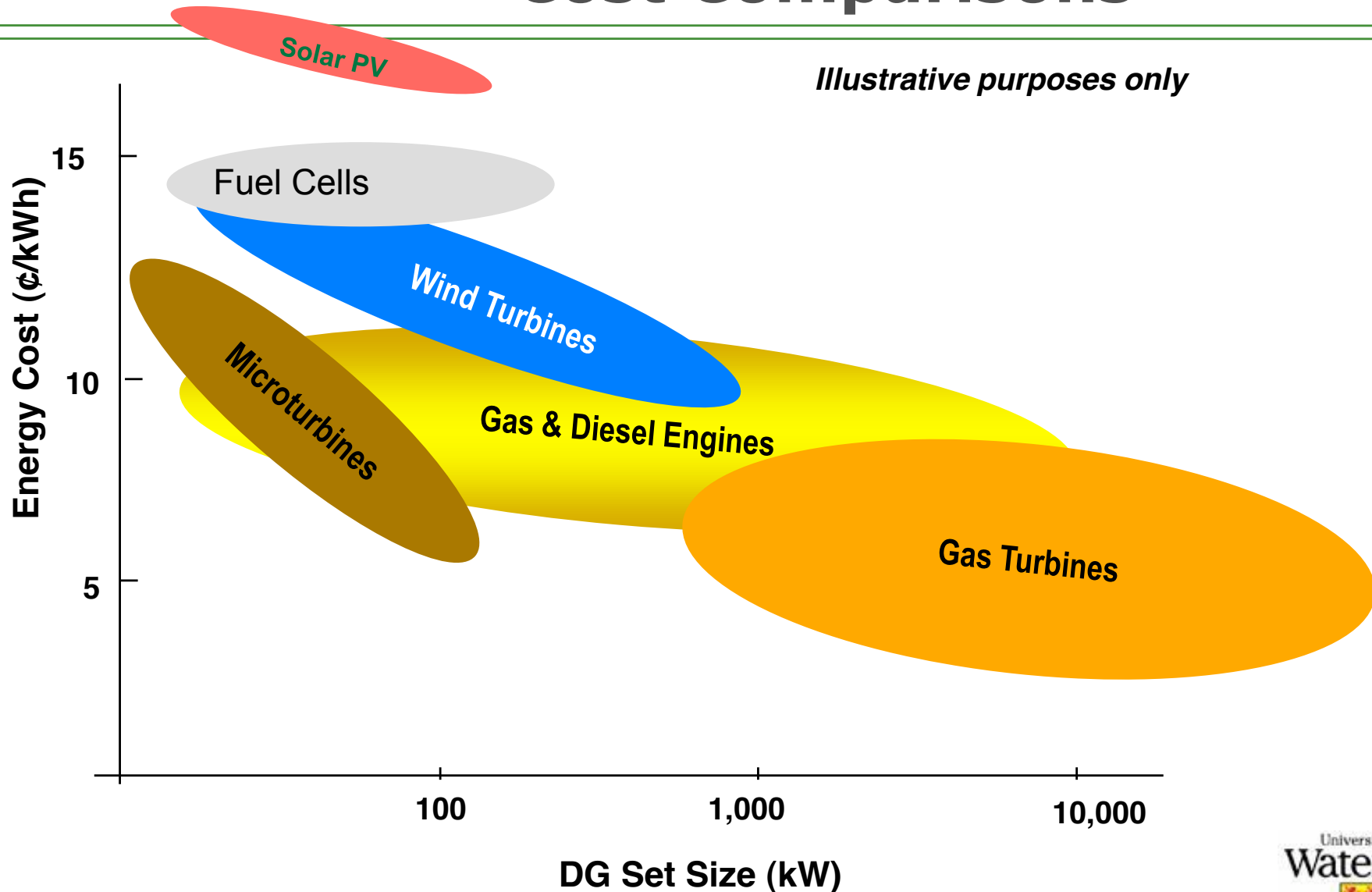
Source: Tokyo Electric Power Company

- Convergence of grid and transportation infrastructures?
- Boon for DG?

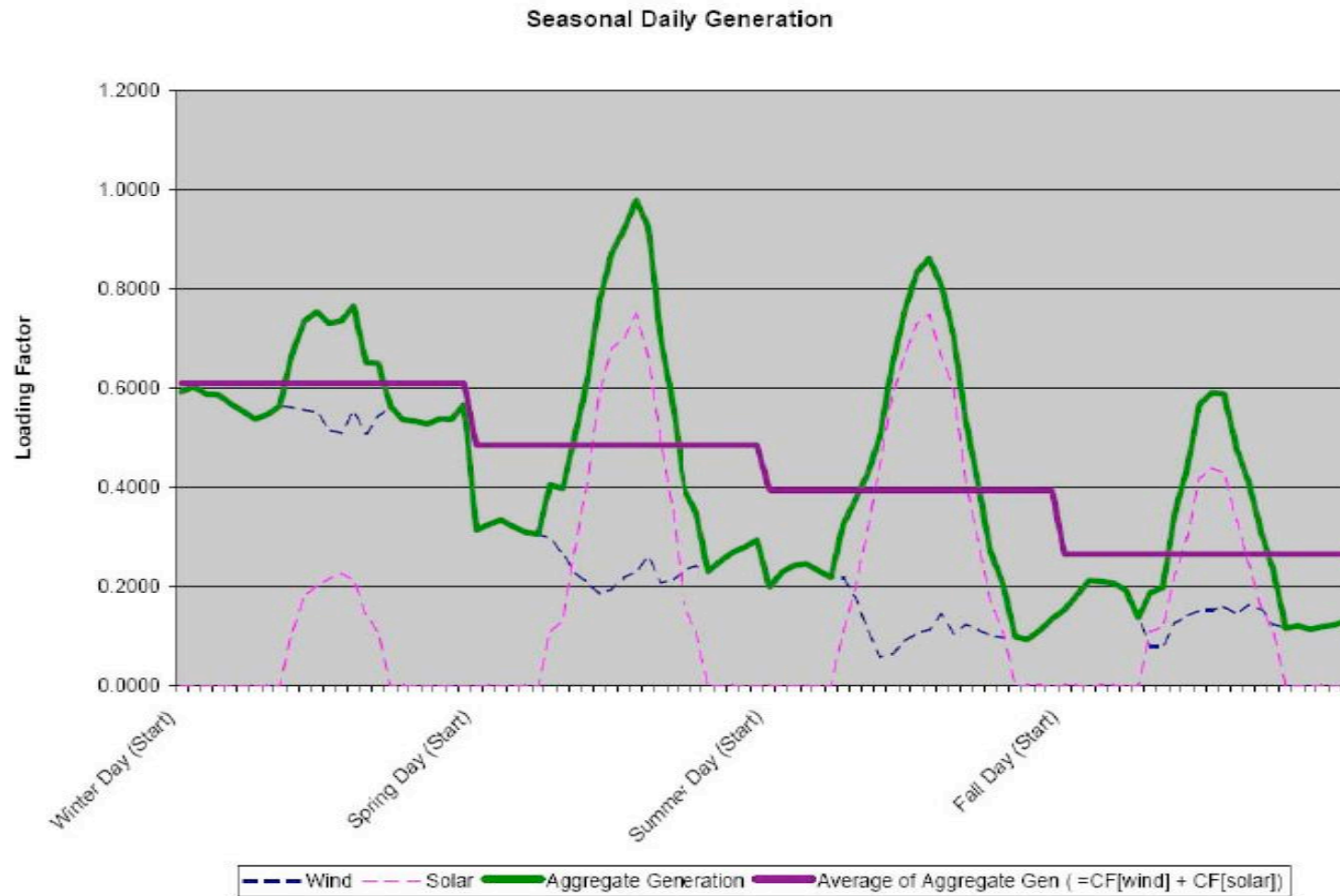




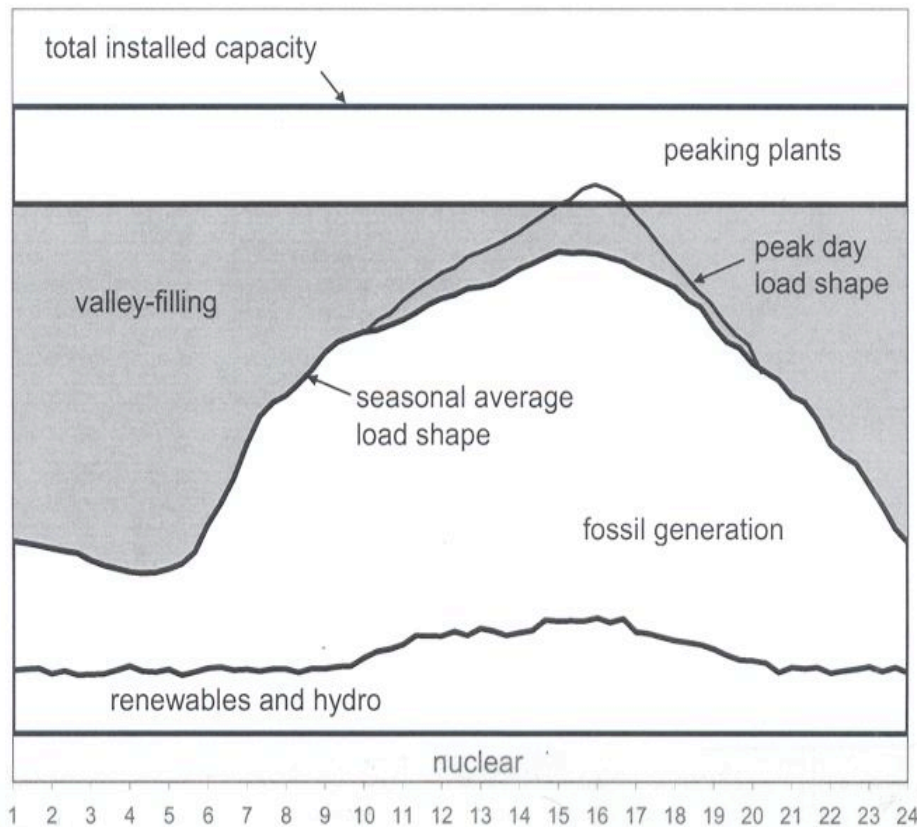
Cost Comparisons



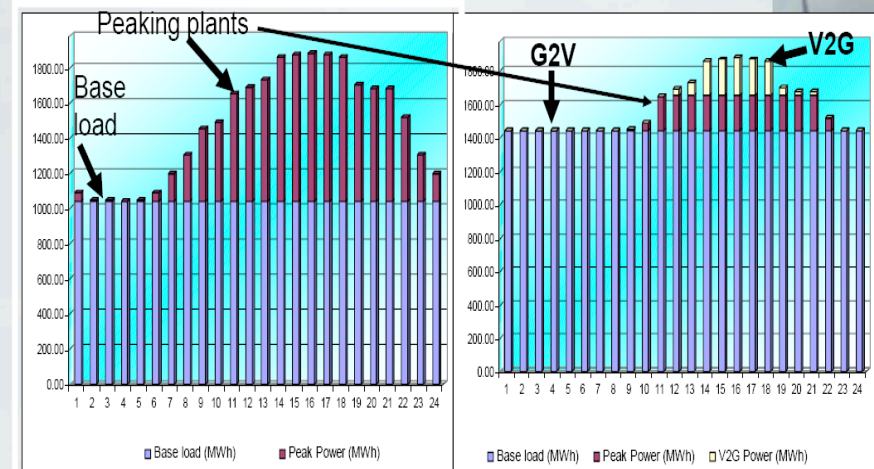
Benefits of Diversity and Distributed Resources



Low cost power to displace gasoline “green electrons as substitutes for carbon”

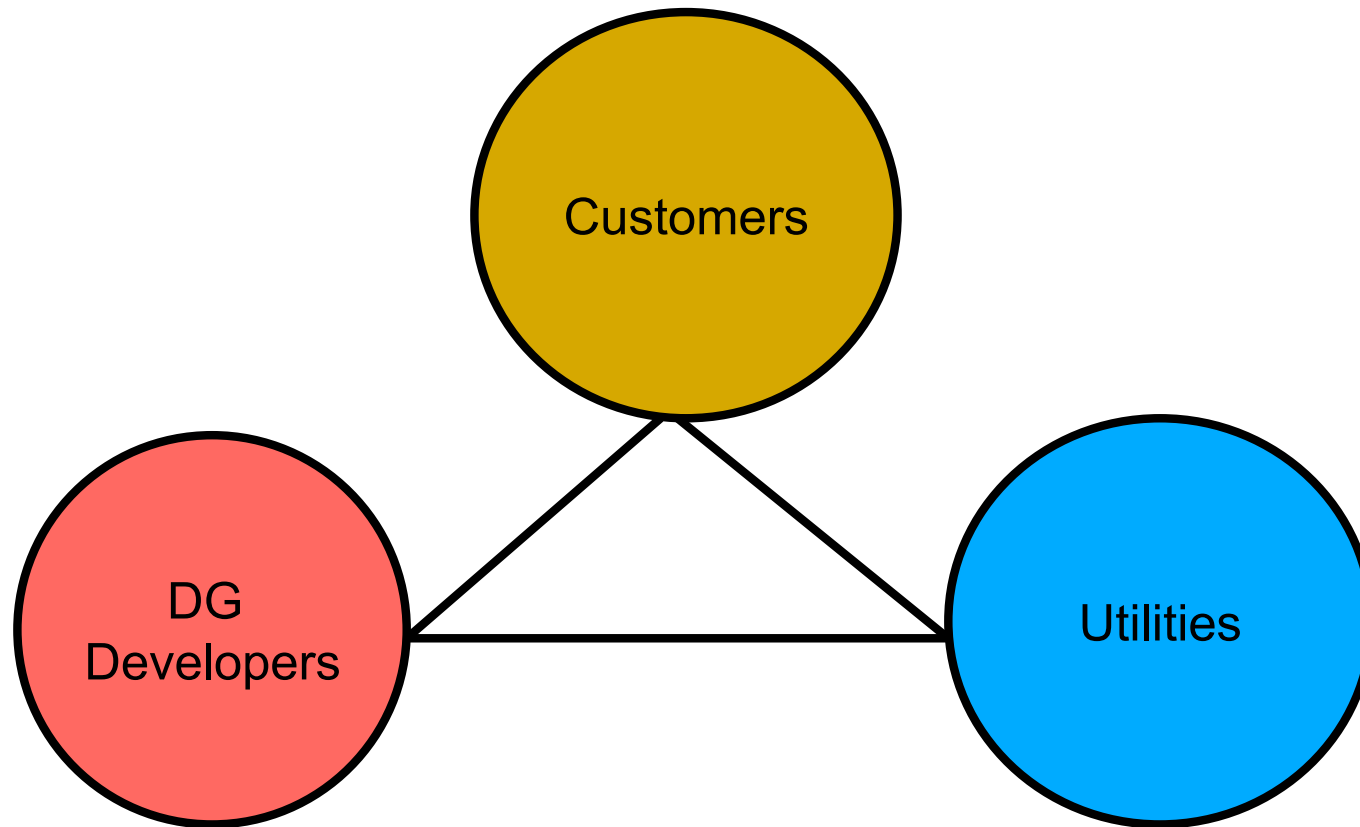


The PHEV can be used to balance the Electric Grid
Integrating electric power and transportation energy.
With only 20% of the cars PHEV the following results.

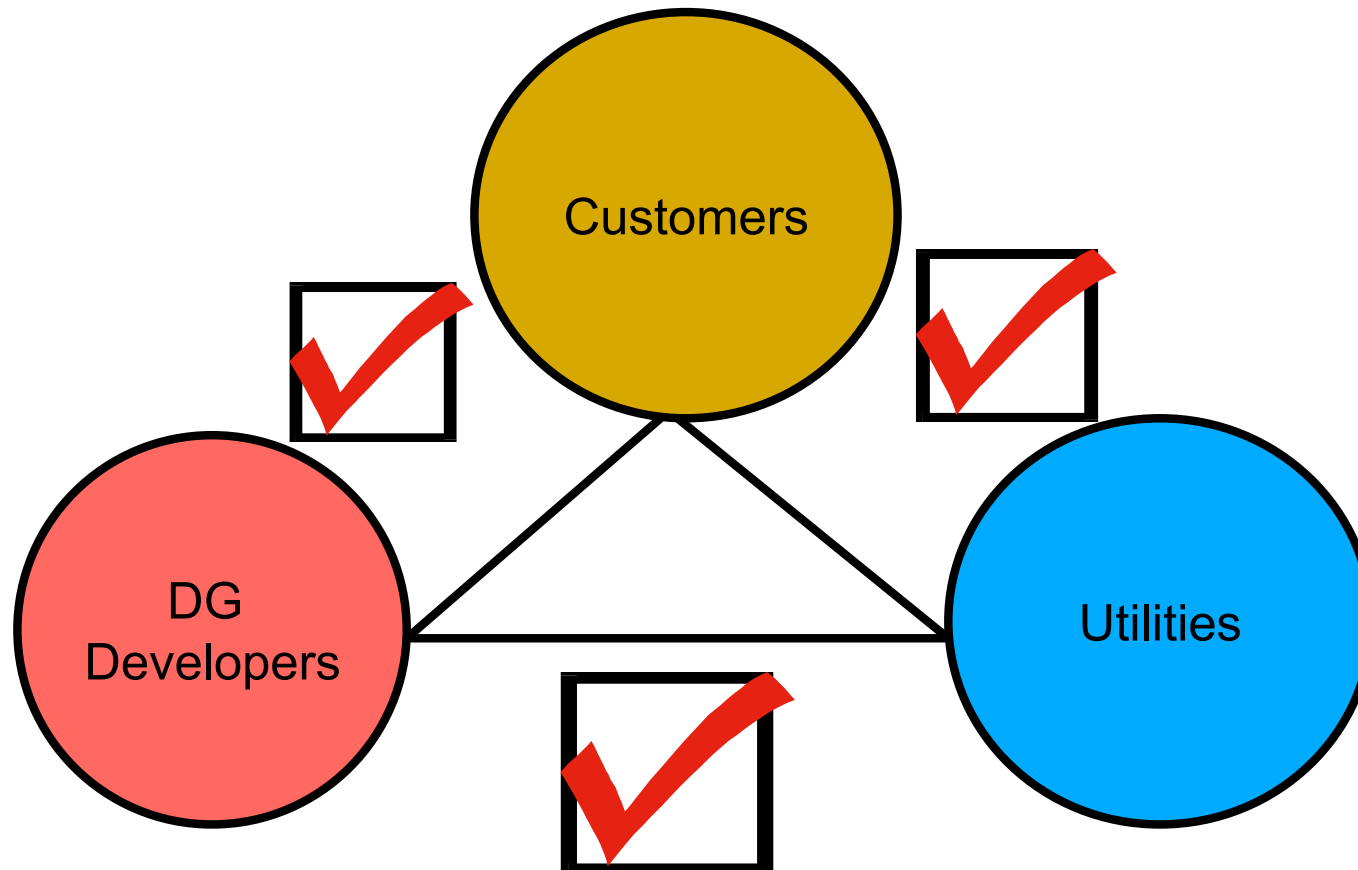


Energy available for the grid (V2G)	0 MWh	Consumption without V2G	35300 MWh	Total Base load before	24960 MWh	Total Peak Power before	10340 MWh
Energy use for recharging vehicles	4 MWh	Consumption with V2G	37068 MWh	Total Base load after	34560 MWh	Total Peak Power after	2508 MWh
No. of vehicles	125000 #	Consumption increase	5.01 %	Base load increase	38.46 %	Peak Power decrease	75.74 %

DG Success Matrix

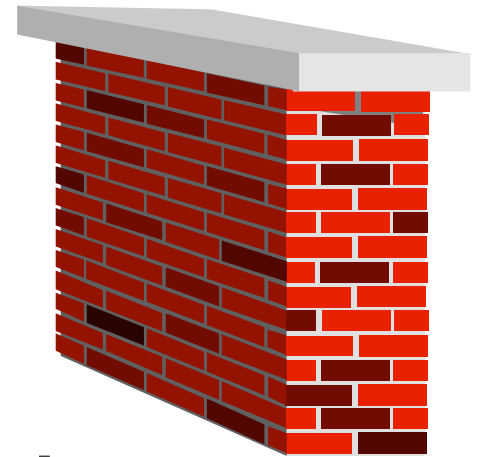


DG Success Matrix: Net positive benefit to society

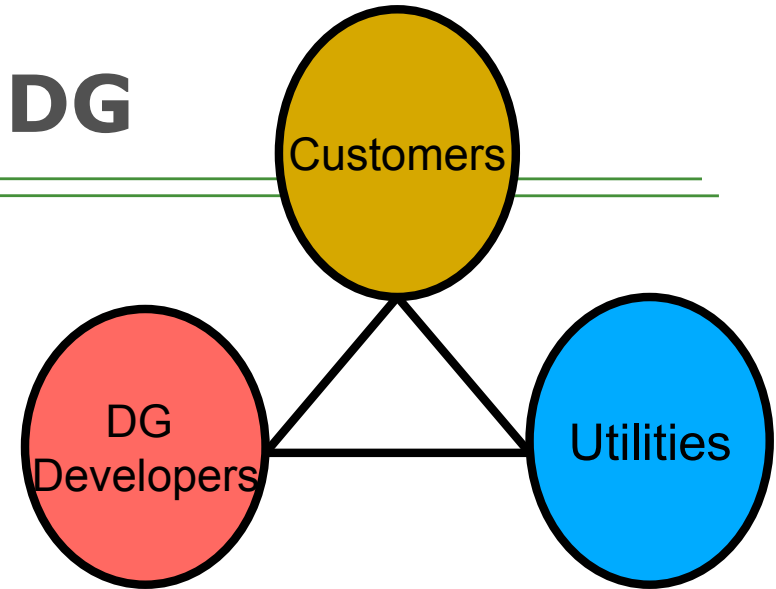
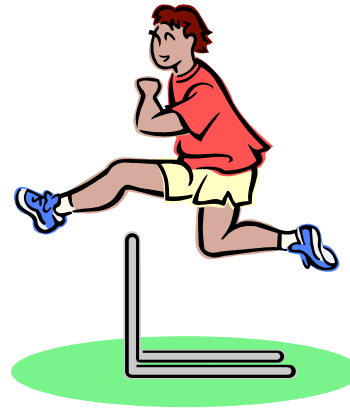


Barriers to DG: Institutional Aspects

- **Cost**
- **Connection Requirements and Costs**
- **Industry Practices**
- **Siting and Permitting Requirements**
- **Compensation & Prices**



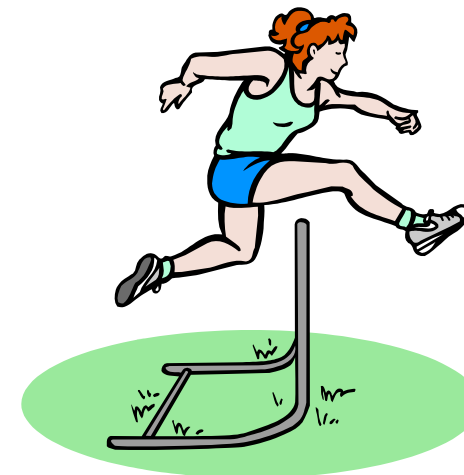
Barriers to DG



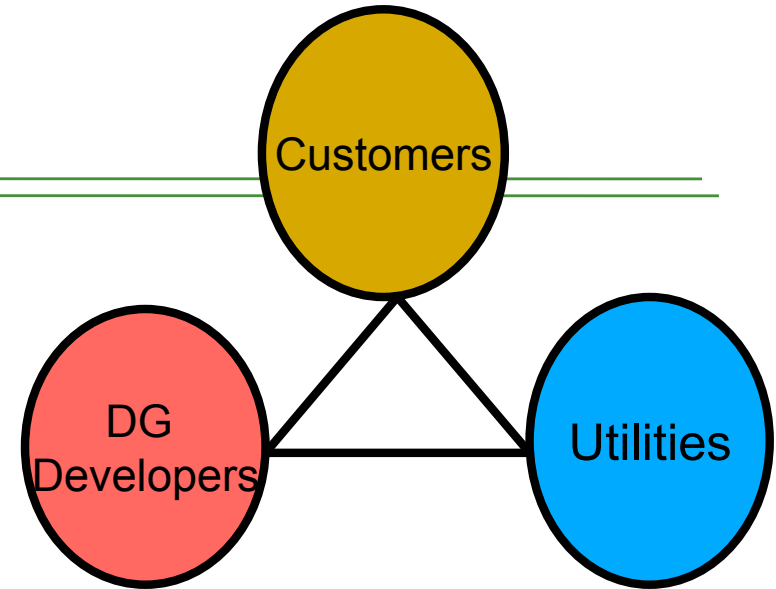
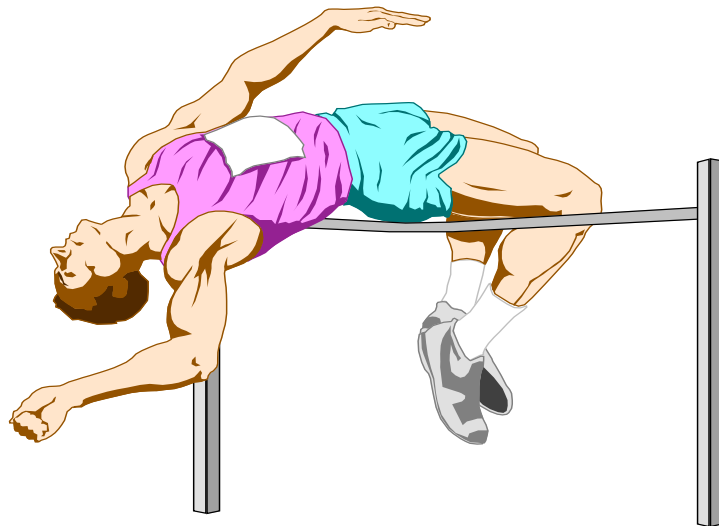
Connection Requirements and Costs

Potential Solutions

- IEEE 1547
- Pre Certification of DG Equipment
- Uniform Contracts



Barriers to DG

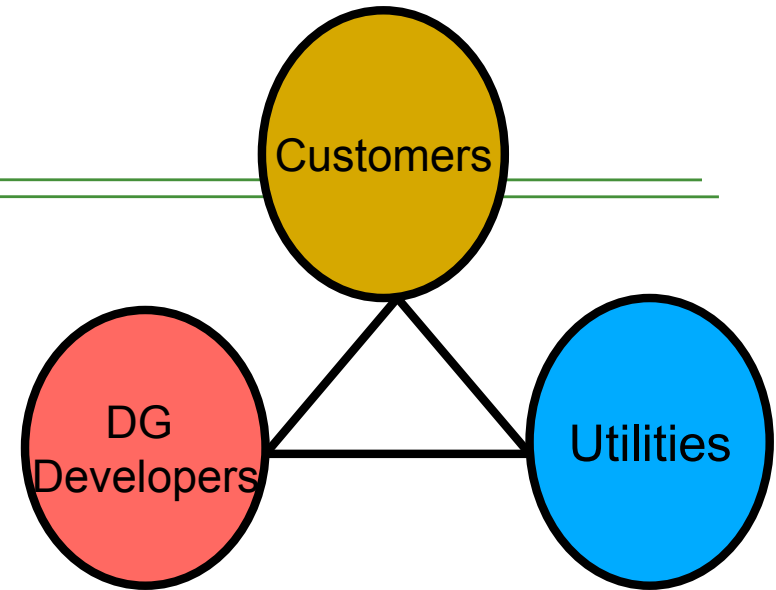
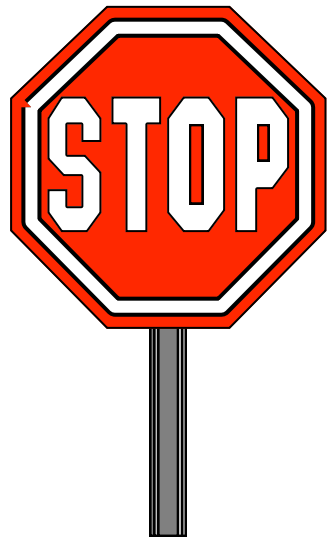


Utility Charge Structure, Compensation for Avoided Costs and Prices for Energy

Potential Solutions

- Regulatory Policies and Frameworks
- DG Incentive Mechanisms
- “Shallow” vs “Deep Connection Charges”

Barriers to DG



- Siting and Permitting Restrictions
- Air quality issues, land-use approvals, building codes

Potential Solutions

- Government Policies
- Promote Uniform Requirements

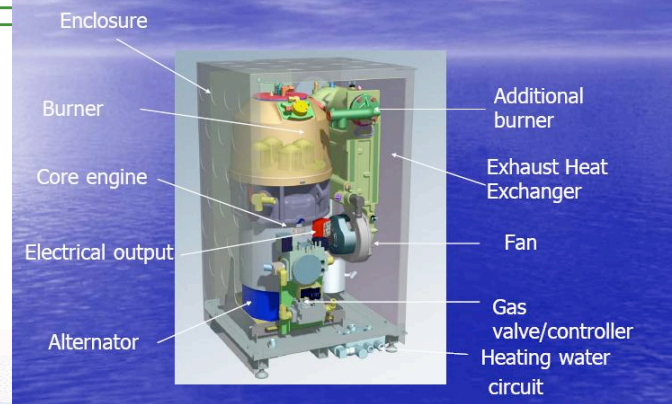
Technology Innovations



- Powered by lithium-ion battery
- Charges in under 1 minute.
- Range: 15 km at 40 km/h.
- Cold weather testing in Sapporo next month.
- Uses 10% less energy than existing streetcars.



WhisperGen Stirling mCHP system



HOT POWER FROM MIRRORS

Small text describing solar power technology.

SOLAR CONCENTRATOR

Diagram showing a solar collector with mirrors reflecting light onto a receiver.

STERLING ENGINE

Diagram showing a Stirling engine with its various components labeled.

Figure 5: Transportability of 5.2-MW turbines to SRP substations

SRP Turbines's 5.2-MW turbines and balance-of-plant equipment will be transportable by truck, allowing Salt River Project to move the units to areas with the greatest distribution system need.



Source: David Gaslett (25)



Summary

- Reducing costs (“technology + transactional”) is the key determinant
- Policy developments and “innovative” regulatory practices are needed to help reduce barriers and enhance prospects for DG
 - Net benefit to society a “reasonable test of inherent value
- Alignment of customer, utility and DG developer interests will lead to productive solutions.

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Will the utility of the future be fundamentally different? Is renewal an “opportunity” to chart a different path?

