KIUC Advisory Group

Supply Side Options

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Jeff Deren

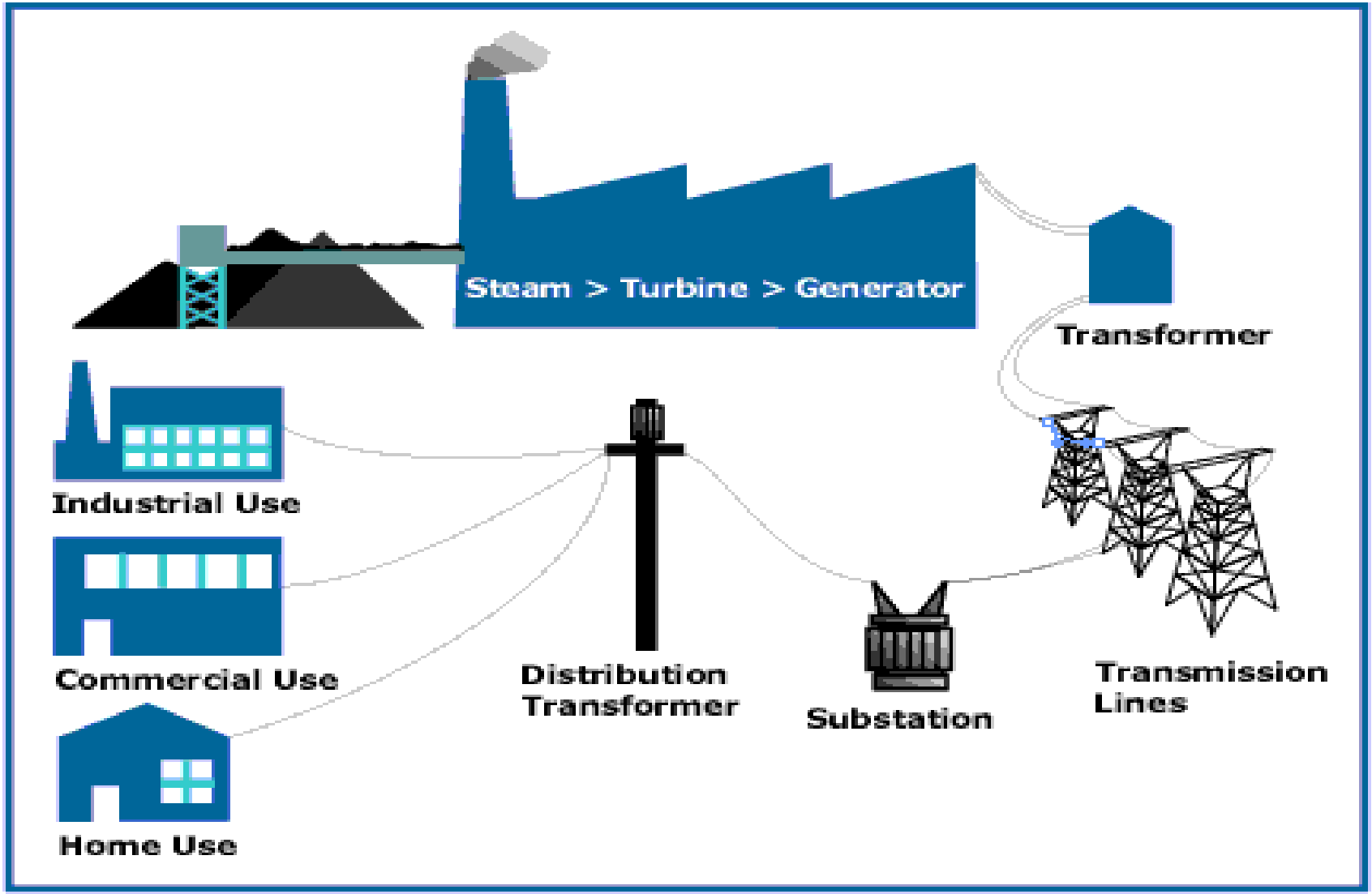
Kaua`i Island Utility Cooperative

Your Touchstone Energy Cooperative

Introduction

- Scope
- Fossil Generation
  - KIUC technologies
  - Other technologies
- Renewable Generation
  - Phase 1 Technologies
  - Phase 2 Technologies
- Summary

Conventional Generation Model



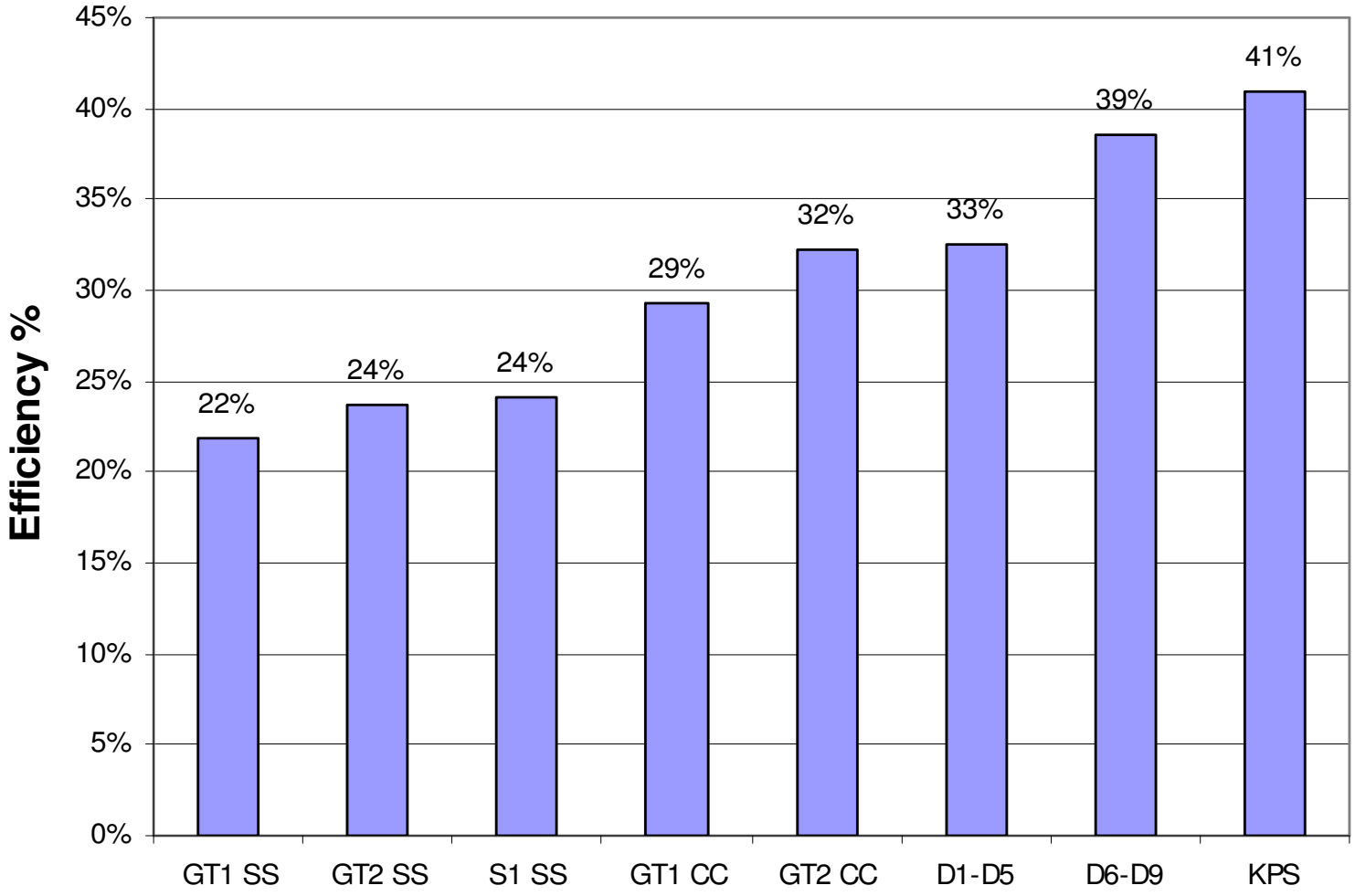
Firm vs Non-Firm Generation

- Capacity vs energy-only generation
  - Can we dispatch or schedule power
- Typical capacity factors
  - Steam turbines – 95%+
  - Photovoltaic – 20%
  - Wind – 30%
  - Wave – 40%
- Capacity required for adequacy of supply
- Most utilities pay for capacity as well as energy

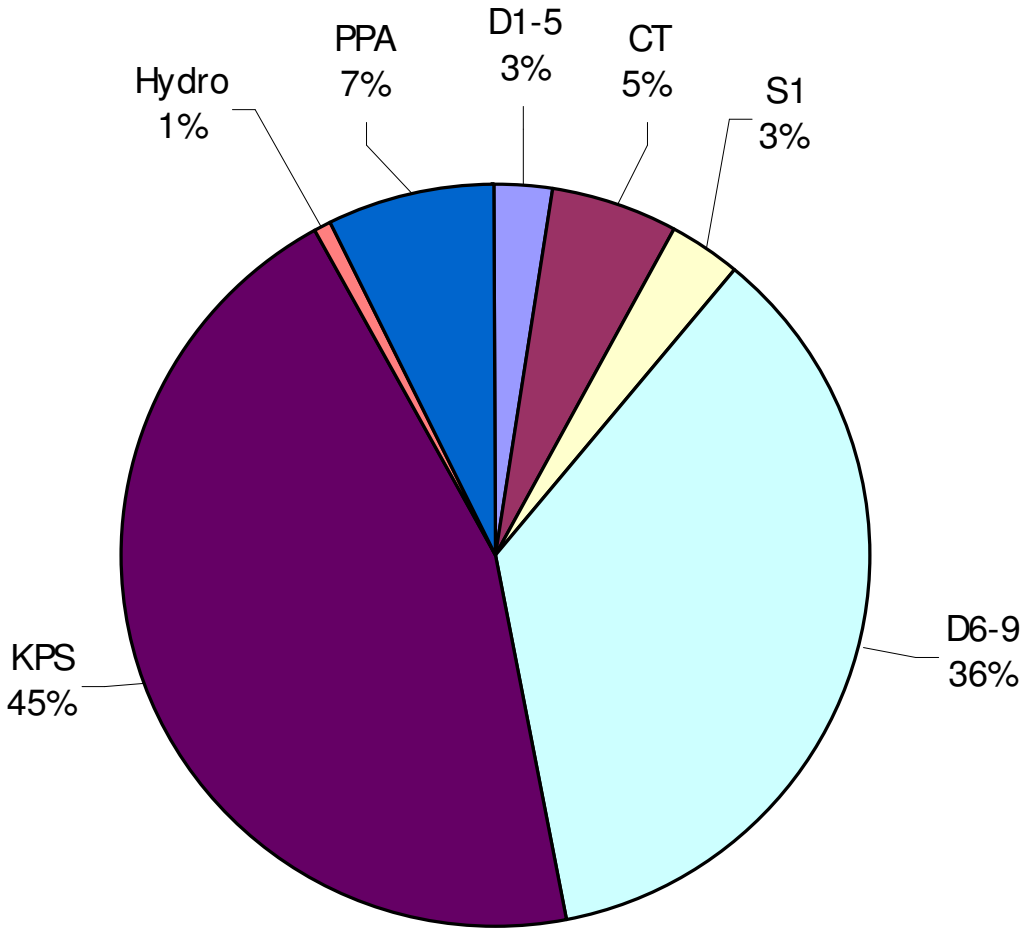
KIUC Generating Units

Name	Type	Fuel	Heat Rate	Year	No x MW
D1 – D5	Internal comb	Diesel	10,500	1964-68	5 x 2
D6 – D9	Internal comb	Diesel	8,646	1987-89	4 x 8
S1	Steam turbine	Diesel*	14,182	1968	10
GT1 (SS/CS)	Comb turbine	Diesel	15,624/ 11,623	1973	19
GT2 (SS/CS)	Comb turbine	Diesel	14,437/ 10,599	1977	24
Kapaia	Steam injected comb turbine	Diesel / naphtha	8,246	2002	28
Upper Hydro	Pelton wheel	Hydro	N.A.	1931	.8
Lower Hydro	Francis wheel	Hydro	N.A.	1914	.5

KIUC Generation Efficiencies



KIUC Generation Mix



Percent of YTD MWh

YTD MWh 352,286

Other Fossil Technologies

- Combined Heat & Power (CHP)
  - Diesel engines, microturbines, fuel cells
  - Utilizes waste heat
  - Good match for customers with large heating loads
  - Efficiencies up to 80%
- Fuel Cells
  - Electrochemical reaction using H_2
  - No emissions other than water
  - Natural gas, ethanol, bio-gas, **electricity** sources of H_2
  - Promising technology but expensive (31-59¢/kWh)

Renewable Technologies

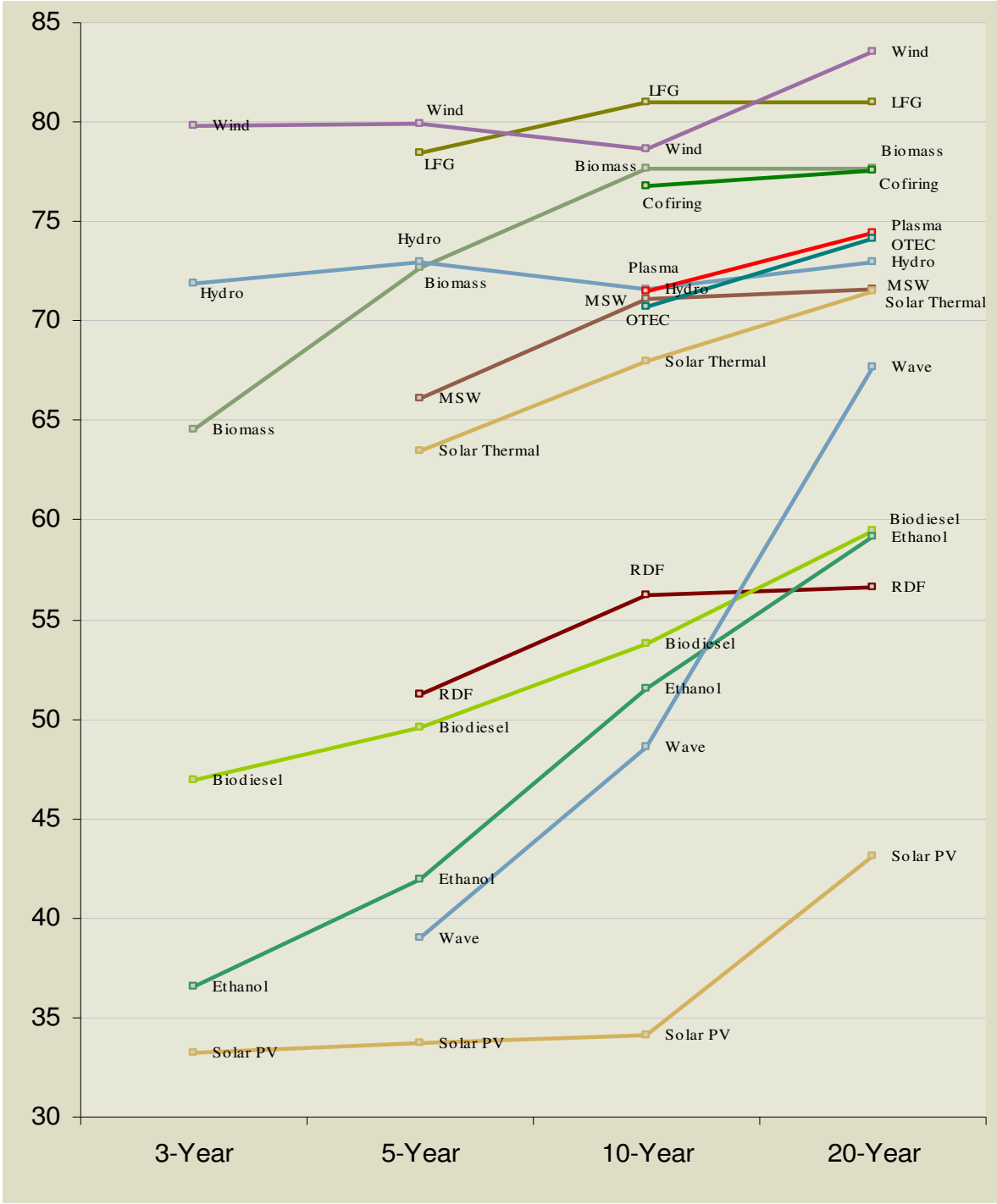
1. Solid Biomass	4. Waste-To-Energy	7. Solar
a. direct fired *	**a. mass burn ***	a. photovoltaic
b. co-firing	b. refuse derived fuel	b. solar thermal
2. Biogas	c. plasma arc	**8. Wind ***
a. anaerobic digestion	**5. Hydroelectric ***	9. Geothermal
b. landfill gas *	6. Ocean energy	10. Multi-fuel technologies
3. Biofuels	a. ocean thermal	a. recip engines
a. ethanol	b. wave	b. fuel cell
b. biodiesel	c. tidal	c. microturbines

* The five technologies carried forward for detailed analysis in Phase II

Scoring Matrix

Criteria	Weight
Cost of energy	50
Kauai resource potential	10
Fit to KIUC needs	10
Technology maturity	10
Environmental impact	7.5
Socio-economic impact	7.5
Incentives / Barriers	5

Scoring Results



Direct Fired Biomass

- Pros
  - Good potential (20 MW optimal)
  - Firm power
  - Mature technology
  - Utilizes existing agricultural infrastructure
- Cons
  - Requires large tracks of land (10% ag land)
  - Higher cost with a fuel crop
- Costs
  - COE 18-20¢/kWh Cap Cost $4,556/kW

Landfill Gas

- Pros
  - Firm power
  - Mature technology*
  - Reduction of greenhouse gas emissions
- Cons
  - Limited potential (810 kW)
  - Fuel declines over 15 yrs
- Costs
  - COE 10¢/kWh Cap Cost $3,965/kW

Municipal Solid Waste

- Pros
  - Mature, proven technology
  - Minimize trash going into landfill
  - Less expensive than fossil generation
- Cons
  - Limited potential on Kauai (7.3 MW)
  - Emissions due to toxins, metals, plastics
- Costs
  - COE 2 -11¢/kWh* Cap Cost $11,350/kW

Hydroelectric

- Pros
  - Good potential for Kauai (60 MW)
  - Less expensive than fossil generation
  - No emissions
- Cons
  - “Run-of- river” facilities are intermittent
  - Environmental impact
  - Significant public opposition
- Costs
  - COE 6 -9¢/kWh Cap Cost $1,700 – 5,700/kW*

Wind

- Pros
  - Good potential for Kauai (6 -10 MW)
  - Less expensive than fossil generation
  - No emissions
- Cons
  - Environmental impact (bird impacts)
  - Wind is intermittent
  - Visual impact
- Costs
  - COE 6 - 10¢/kWh Cap Cost $1,200 – 1,600/kW

Biodiesel*

- Pros
  - Can be used in existing equipment (B10)
  - Lower sulfur & particulate emissions
  - Utilizes existing ag infrastructure
- Cons
  - May cost more than conventional generation
  - Higher NOx emissions
  - Requires large tracks of land to grow oil crops
- Costs
  - Currently evaluating

RPS Compliance*

Sample Projects

1. 2 MW hydro at 65% CF = 11,388 MWh
2. .5 MW PV at 20% CF = 876 MWh
3. 20 MW biomass at 85% CF = 148,920 MWh

Year	RPS %	Renewable Gen (MWh)
2005	7.0%	6
2006	7.0%	728
2007	8.0%	1,463
2008	8.0%	2,213
2009	8.0%	2,979
2010	8.0%	13,713
2011	8.0%	14,708
2012	10.0%	15,723
2013	10.0%	16,759
2014	10.0%	17,815
2015	15.0%	46,365
2016	15.0%	48,013
2017	15.0%	49,694
2018	15.0%	51,409
2019	15.0%	53,159
2020	20.0%	85,275

Summary

- Currently 92% fossil generation
- Renewable technologies are viable
- Need firm power as well as energy-only
- Renewable and fossil generation will be evaluated in the IRP