FUEL CELLS vis-à-vis WIND TURBINES and PHOTOVOLTAICS

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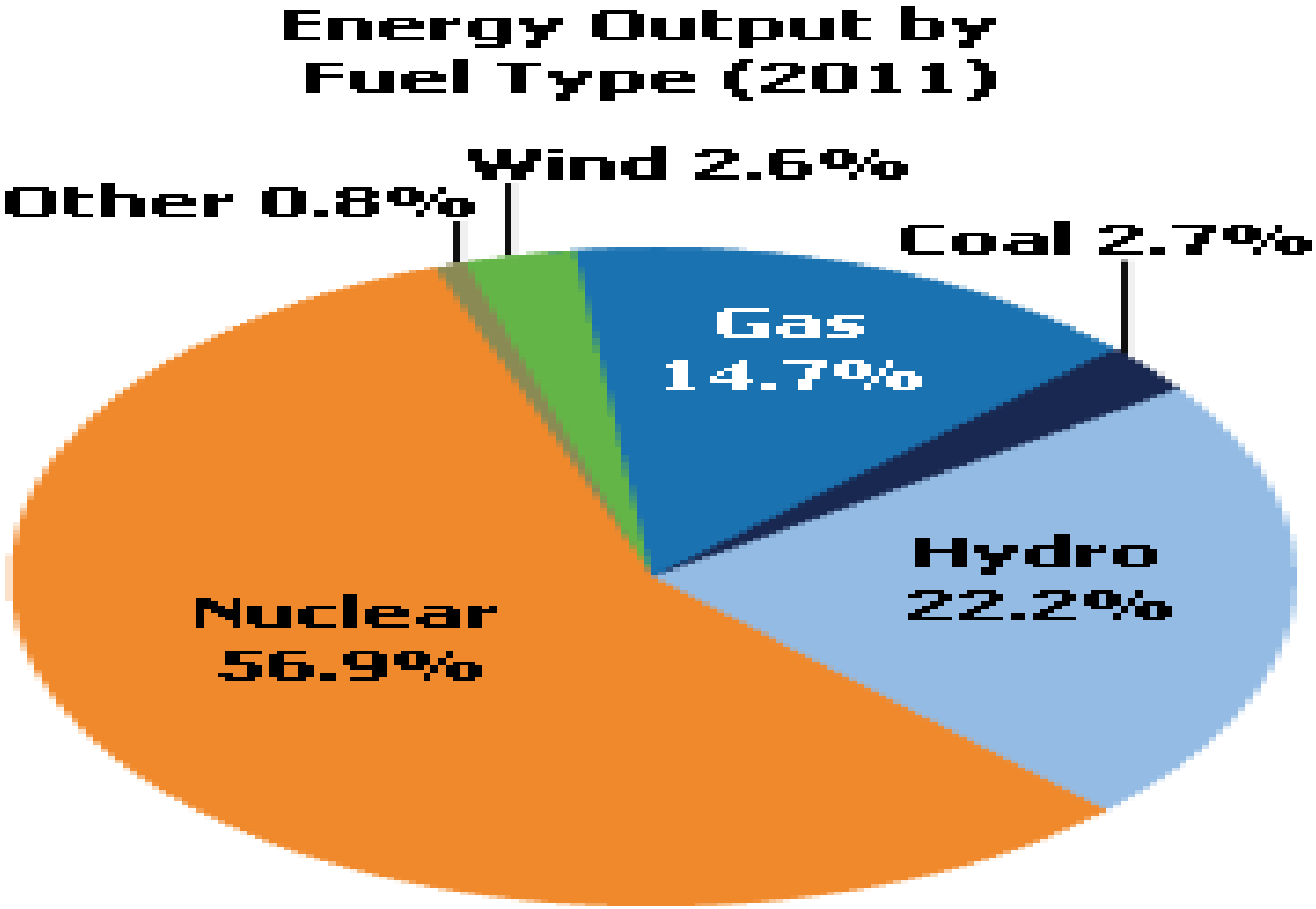
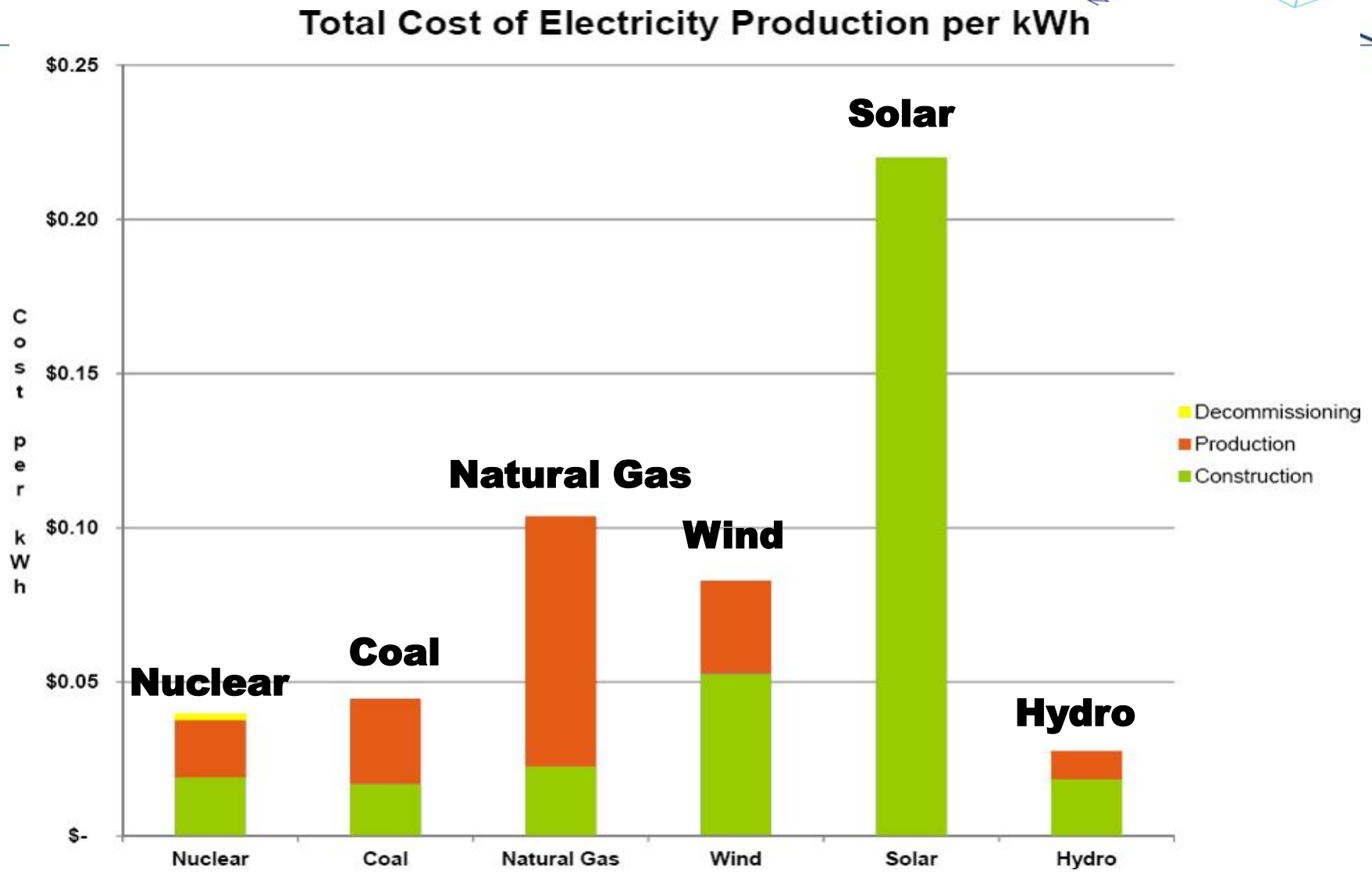
From IESO


Energy Output by Fuel Type (2011)
Wind 2.6%
Other 0.8%
Coal 2.7%
Gas 14.7%
Hydro 22.2%
Nuclear 56.9%

Ontario Energy Board (OEB): Consumer's Electricity Cost

Average cost for March (weighted)	**2.2 ¢/kWh**
Residential Consumer	
NO SMART METER	**7.1 ¢/kWh**
SMART METER	
Weekends/Holidays	**6.2 ¢/kWh**
Winter Weekdays	
(November 1 to April 30)	
7 am to 11 am	**10.8 ¢/kWh**
11 am to 5 pm	**9.2 ¢/kWh**
5 pm to 7 pm	**10.8 ¢/kWh**
7 pm to 7 am	**6.2 ¢/kWh**

Estimates vary wildly – here is one of them



Why Fuel Cells? They are catching up with wind turbines and photovoltaics

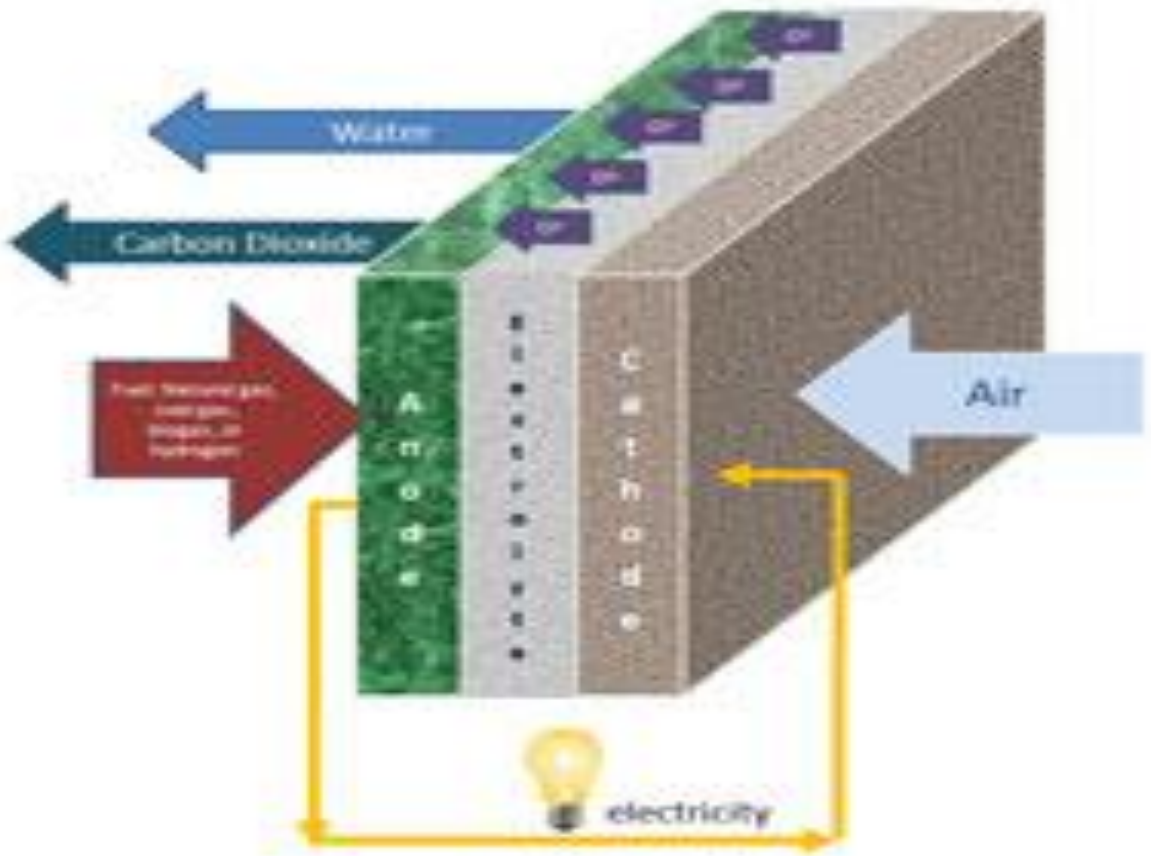
	$/kW
SOLAR	**6,000-9,000**
WIND	**2,000-3,000**
Add storage	**1,000-6,000**
TOTAL WIND	**3,000-9,000**
FUEL CELLS	**4,000-5,000**

US DOE . **Estimated Levelized Cost of New Generation Resources, 2016.**

Plant Type	Capacity Factor (%)	U.S. Average Levelized Costs (2009 $/megawatthour) for Plants Entering Service in 2016				
		Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Conventional Coal	85	65.3	3.9	24.3	1.2	94.8
Advanced Coal	85	74.6	7.9	25.7	1.2	109.4
Advanced Coal with CCS	85	92.7	9.2	33.1	1.2	136.2
Natural Gas-fired						
Conventional Combined Cycle	87	17.5	1.9	45.6	1.2	66.1
Advanced Combined Cycle	87	17.9	1.9	42.1	1.2	63.1
Advanced CC with CCS	87	34.6	3.9	49.6	1.2	89.3
Conventional Combustion Turbine	30	45.8	3.7	71.5	3.5	124.5
Advanced Combustion Turbine	30	31.6	5.5	62.9	3.5	103.5
Advanced Nuclear	90	90.1	11.1	11.7	1.0	113.9
Wind	34	83.9	9.6	0.0	3.5	97.0
Wind – Offshore	34	209.3	28.1	0.0	5.9	243.2
Solar PV[1]	25	194.6	12.1	0.0	4.0	210.7
Solar Thermal	18	259.4	46.6	0.0	5.8	311.8
Geothermal	92	79.3	11.9	9.5	1.0	101.7
Biomass	83	55.3	13.7	42.3	1.3	112.5
Hydro	52	74.5	3.8	6.3	1.9	86.4

Fuel Cell: Chemical Generator

Works like a battery but never looses charge as long as there is fuel supply

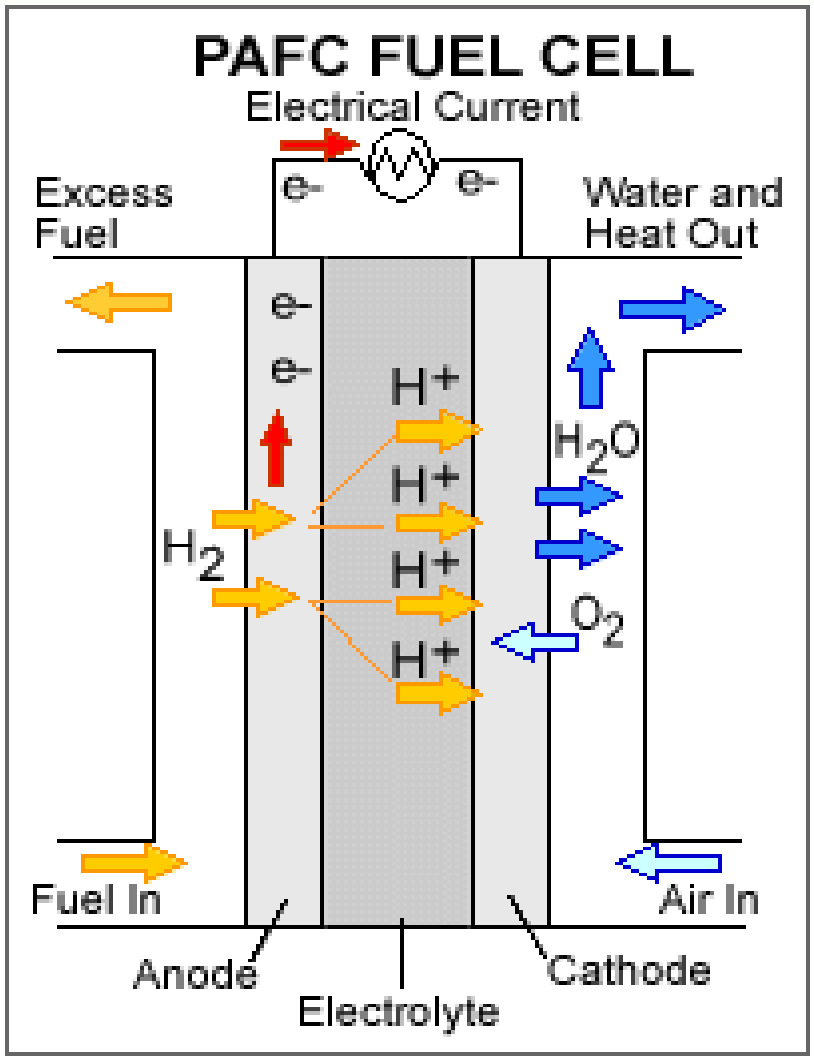


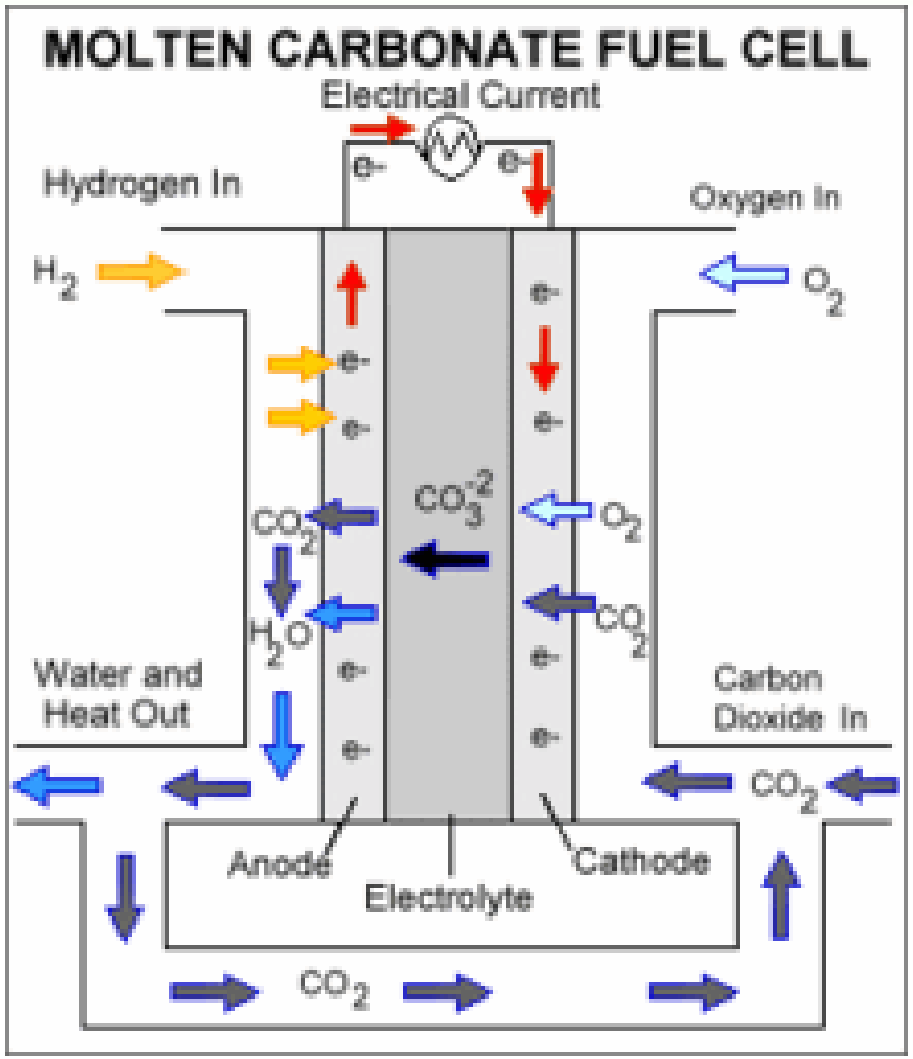
Fuel Cells for commercial power:

1. Phosphoric Acid PAFC

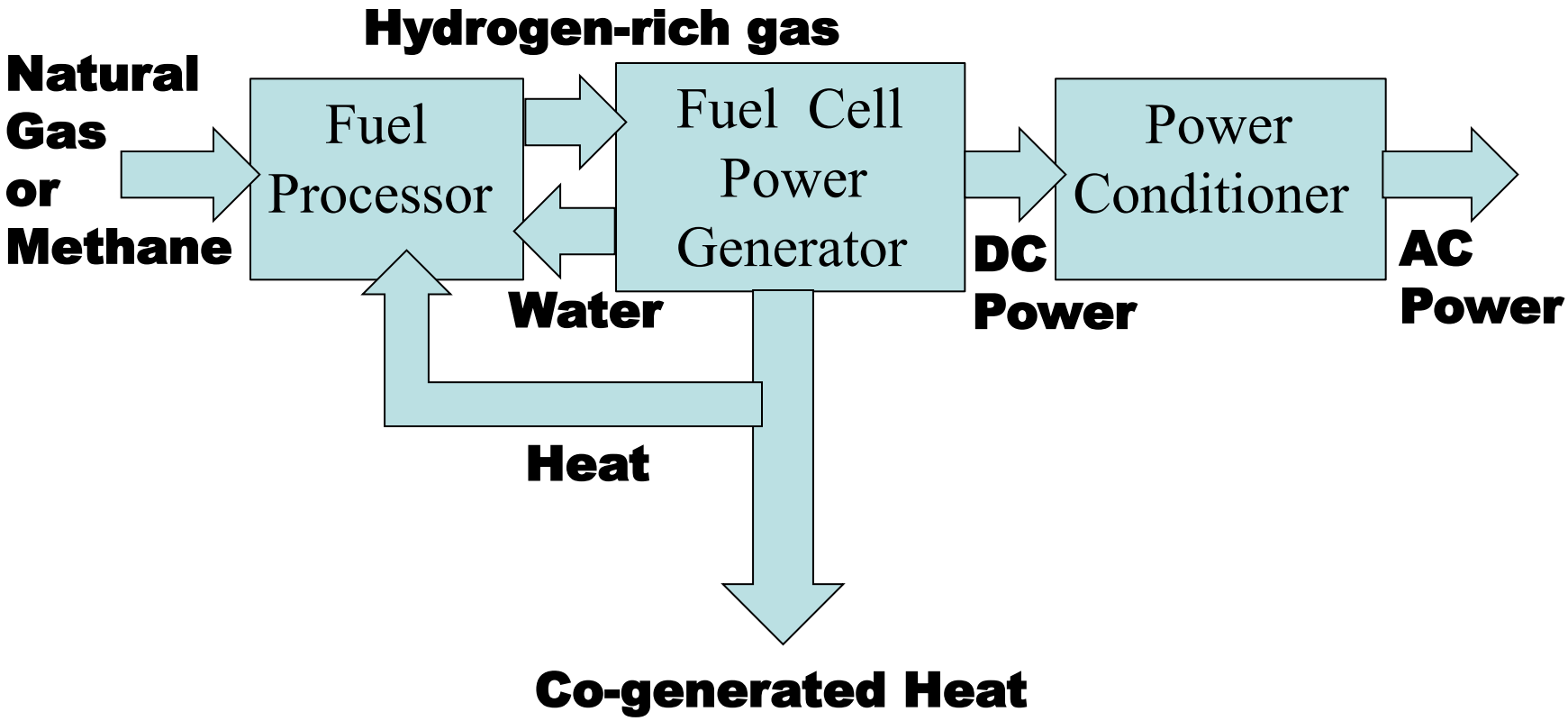
2. Molten Carbonate MCFC

Fuel Cells for commercial power





Fuel Cell Power Plant



Phosphoric Acid PAFC's And Power Plants

100kW Phosphoric Acid FC Unit

Fuji Electric

400kW Phosphoric Acid FC Unit

UTC Power: Supermarket installation

4.8 MW Industr.Plant + district heating

UTC Power 12x400kW units

Molten Carbonate MCFC's and Power Plants

300kW Molten Carbonate FC Unit

FuelCell Energy DFC300

600kW Molten Carbonate FC Plant

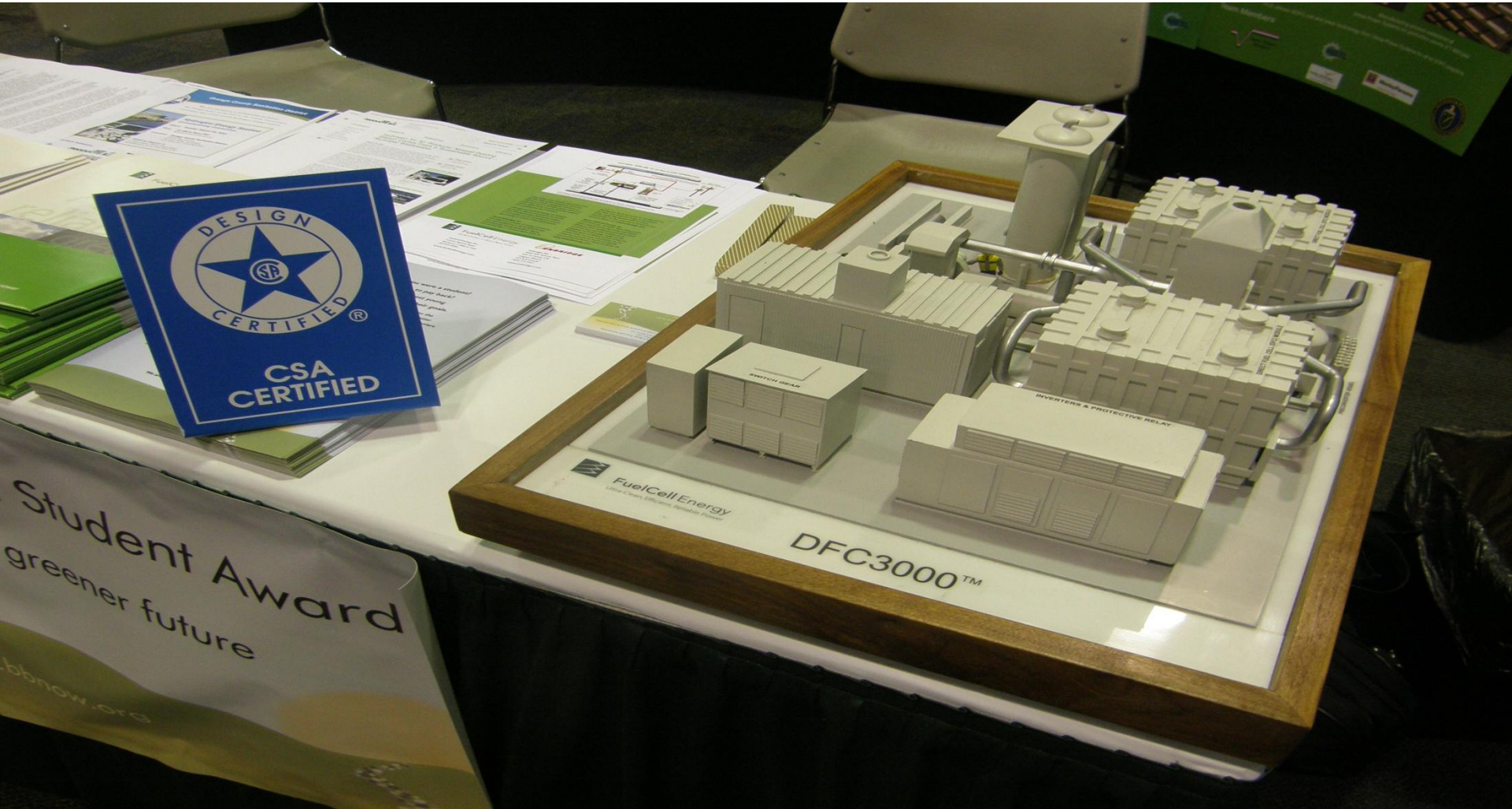
FuelCell Energy 2xDFC300 Plant

3 MW Molten Carbonate FC Plant

FuelCell Energy 2xDFC1500 Plant

MODEL of 3 MW power station

by FuelCell Energy at the Orlando Fuel Cell Conference & Exhibit November 2011



2.2 MW Hybrid Plant at Pipline Letdown Station

FCE/Enbridge Installation

CONCLUSION

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PREDICTION

In process of decentralization of electrical energy generation we an expect to witness appearance of smaller local generation based on improved solar solutions and fuel cells.

Deficiency of large moving parts seem to label Wind Turbines as an interim solution.

THE END