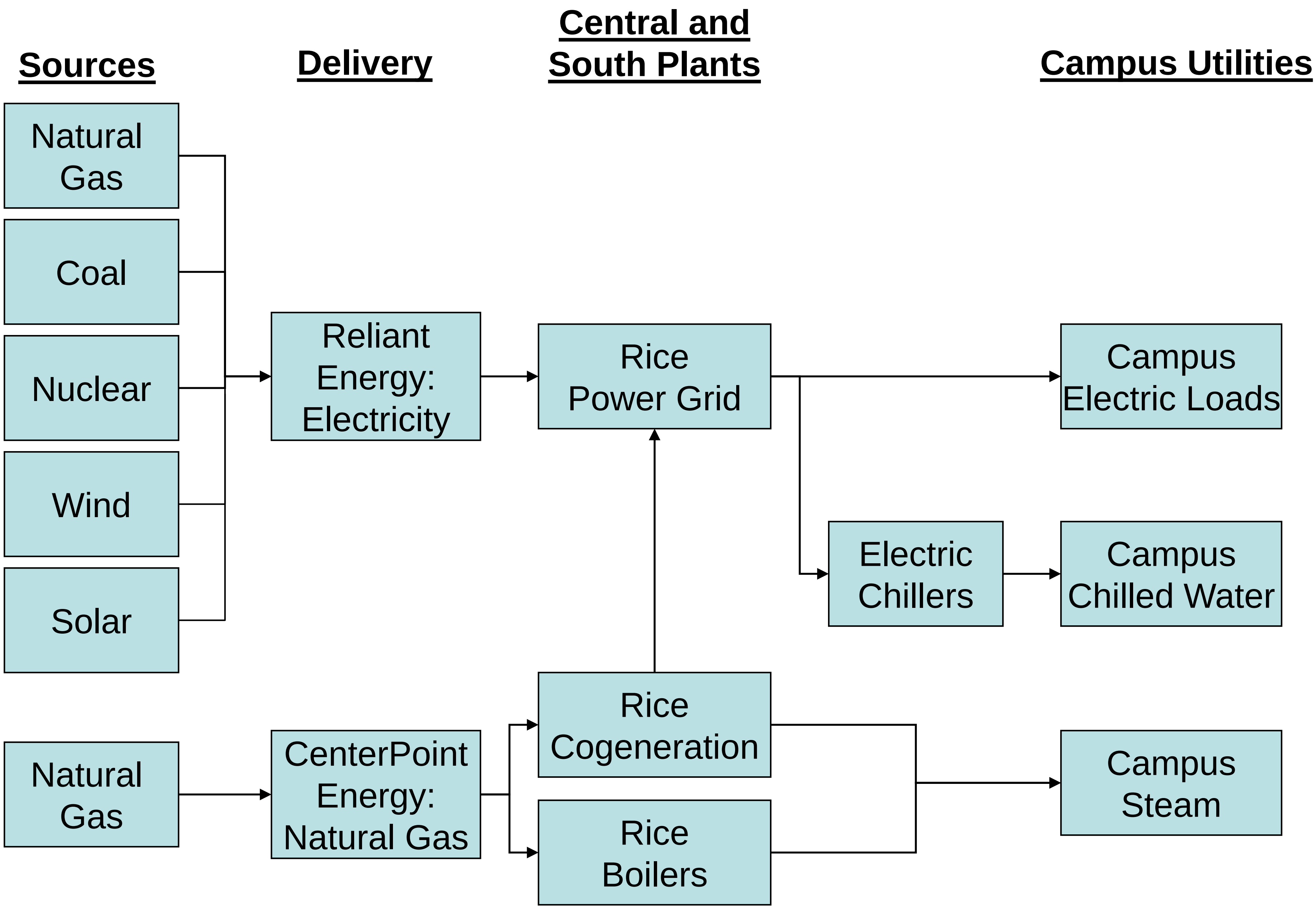
Energy and Climate Planning at Rice

RICE UNIVERSITY

Richard R. Johnson
Admin. Center for Sustainability and Energy Management
28 March 2018

Rice Energy Flow Chart, circa 2012



Issues, circa 2012

<u>Rice needed:</u>

- **An equipment assessment of major assets in utility plants.**

- **A long-term investment plan for energy infrastructure.**

- **A focused, fundable approach to building-level energy conservation efforts.**

- **A Climate Action Plan to help the university reach its goal of becoming carbon neutral.**

- **A justifiable investment plan to sustain building-level meters.**

RICEMaP: The Rice Integrated Climate and Energy Master Plan

(a brief introduction)

Introduction

Project Approach

- Bundled needs into the Rice Integrated Climate and Energy Master Plan (RICEMaP).
  - Report 1: Plant equipment assessment, infrastructure investment plan, and climate action plan
  - Report 2: Building energy audits
  - Report 3: Meter assessment and investment plan
- The intent was to develop synergistic insights from both demand-side and supply-side investigations.

Key Dates

- Consultant (Sebesta) hired in Fall 2012.
- Plan completed and adopted by Rice in Fall 2013.

Demand-Side Energy Management

Rice Integrated Climate and Energy Masterplan (RICEMaP)

Report #2 – Building Level Efficiency
Building Group 2

Rice Project No. B71304

Sebesta Project No. 560250.00

Rice University

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8.4 RMC / Ley Center

ECM No.	Energy Conservation Measure (ECM)	Estimated Implementation Cost[1]	Estimated Annual Utility Savings			Estimated Annual Cost Avoidance	Simple Payback Years	Annual MTCO2e Reduction	Cost per MTCO2e Reduction ($/MTCO2e)	Notes
			Electric (kWh)	Chilled Water (MMBtu)	Steam (Mpounds)					
1.1	25W Fluorescent T-8s in Lieu of 32W	$1,210	3,333	-	-	$250	4.8	1.8	$655	
1.2	Replace Incandescent with Compact Fluorescent	$1,430	31,891	-	-	$2,392	0.6	17.7	$81	
1.3	Occupancy Sensor Control of Lighting	$1,300	3,814	-	-	$286	4.5	2.1	$615	4
1.4	Retrofit T-12 Fixtures with T-8	$1,170	256	-	-	$19	60.9	0.1	$8,245	
1.5	Replace Incandescent Lighting with LED	$8,910	33,615	-	-	$2,521	3.5	18.6	$478	3
2.1	Dehumidification Sequence Modifications	$12,090	-	329	283	$3,645	3.3	30.3	$398	5
2.5	Condensate Pump Float Switch Repair	$1,210	3,917	-	-	$294	4.1	2.2	$557	
3.1	Relocate Chilled Water Differential Pressure to Remote Location	$1,300	4,857	-	-	$364	3.6	2.7	$483	
3.3	Replace Pneumatic Controls with DDC	$362,040	162,193	1,291	739	$23,971	15.1	185.8	$1,949	6
3.4	Chilled Water Differential Setpoint Reset	$1,560	12,740	-	-	$955	1.6	7.1	$221	
3.7	Install VFD on Heating Water Pump	$26,130	67,580	-	-	$5,068	5.2	37.5	$698	7
3.9	Active Kitchen Hood Control	$11,180	8,043	448	6	$3,024	3.7	22.2	$504	
3.10	Install VFD on Variable Volume Unit	$4,940	5,688	-	-	$427	11.6	3.2	$1,567	8
3.11	CO2 Control of Outside Air	$8,060	-	251	125	$2,167	3.7	17.5	$462	9
3.12	Convert Single Zone Constant Volume Units to VAV	$30,290	42,022	-	-	$3,152	9.6	23.3	$1,300	
4.5	Install Bypass Check Valve Around Chilled Water Pump	$4,030	17,543	-	-	$1,316	3.1	9.7	$414	10
4.6	HVAC Overhaul	$1,455,300	283,838	2,259	1,293	$41,949	34.7	325.1	$4,476	11
4.7	Convert Multizone Units to VAV w/ Reheat	$132,440	14,564	593	187	$5,492	24.1	42.6	$3,107	12

Space Science Energy Conservation Project

Sampling of Energy Conservation Measures

- Nighttime temperature setbacks in offices
- Fix leaking steam pressure relief valve
- Replace leaking steam valve
- Install occupancy sensors to control lighting (underway)
- Install low-flow aerators on restroom faucets
- Enact changes in building controls programming
- Prepare and implement an air balance plan, adjust number of air changes in labs

Consultant Recommendation

Implementation Cost:	$192,100
Expected Savings:	$83,631
Est. payback:	2.3 years

Sample project: Leaky pressure relief valve on roof repaired, preventing loss of steam

Space Science Energy Conservation Project

Results to Date

• Chilled water use:	30% reduction
• Steam use:	25% reduction
• Electricity:	20% reduction

Actual project cost: $190,122

Sample project: Leaky pressure relief valve on roof repaired, preventing loss of steam

A Few Key Findings

- **Several buildings found to be 50%+ above Energy Star benchmark for energy use per square foot for their building type.**
- **Campus-wide estimate of "fast payback" building energy use reduction opportunities:**
  - **25% steam, 20% chilled water, and 15% electricity**
- **With plant operational improvements plus building efficiency measures, total "fast payback" campus energy use reduction opportunities estimated at:**
  - **30% steam, 30% chilled water, and 20% electricity**
- **Carbon neutral date set for 2038 using 2013 baseline.**
  - **Interim goal of 20% reduction by 2023.**

USE LESS

BUY GREEN

SEQUESTER CARBON

Consultant’s Recommendations: 2013

- **Implement campus-wide demand-side energy management**
- **Implement Central Plant operational improvements**
- **Expand co-generation**
- **Use sequestration to offset remaining carbon emissions**
- **Acquire “Renewable Energy Credits” as a strategy for “greening” electricity**
- **Develop on-site renewable energy systems when economically and environmentally justifiable.**

USE LESS

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- Implement Central Plant operational improvements

BUY GREEN

- Acquire “Renewable Energy Credits” as a strategy for “greening” electricity
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SEQUESTER CARBON

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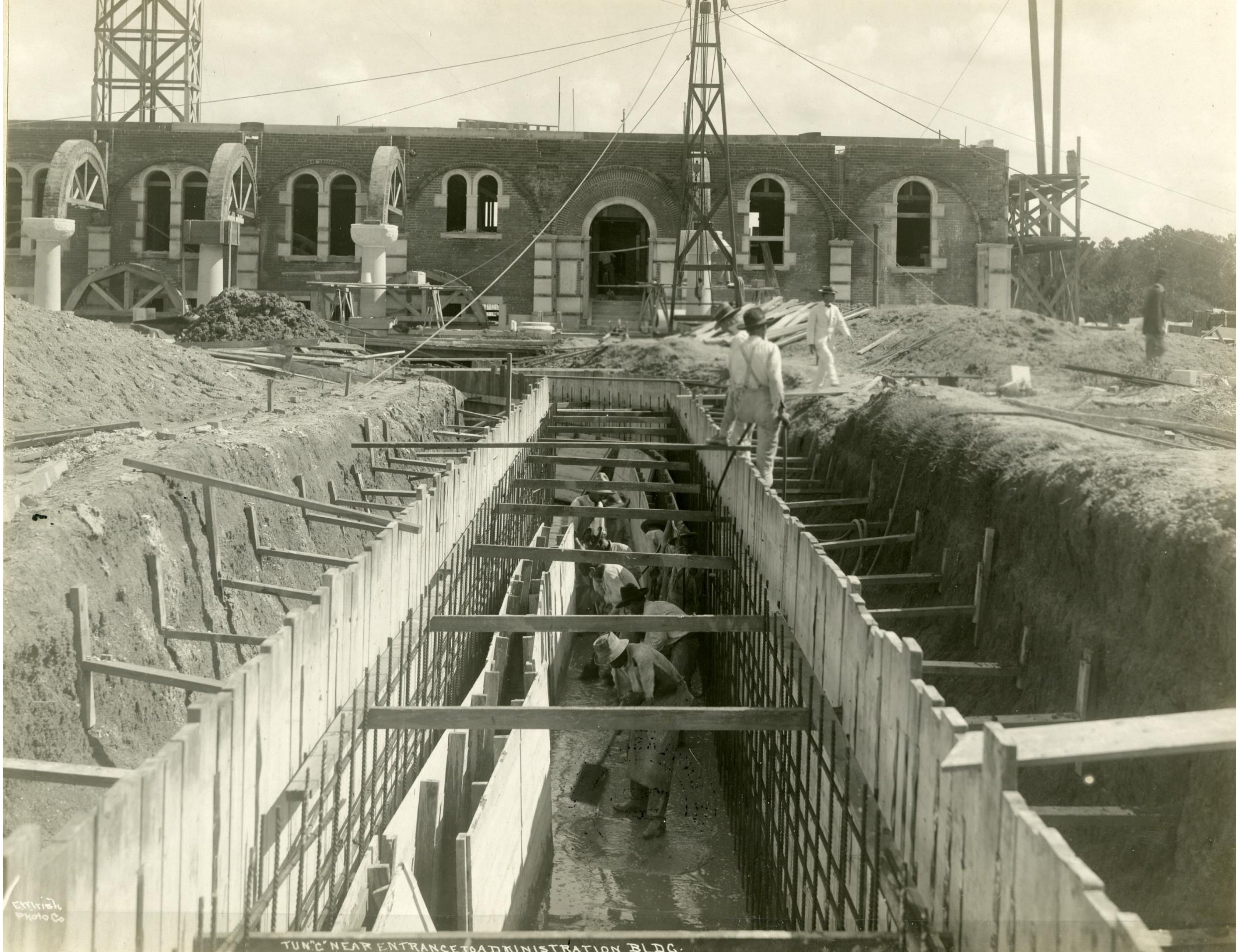
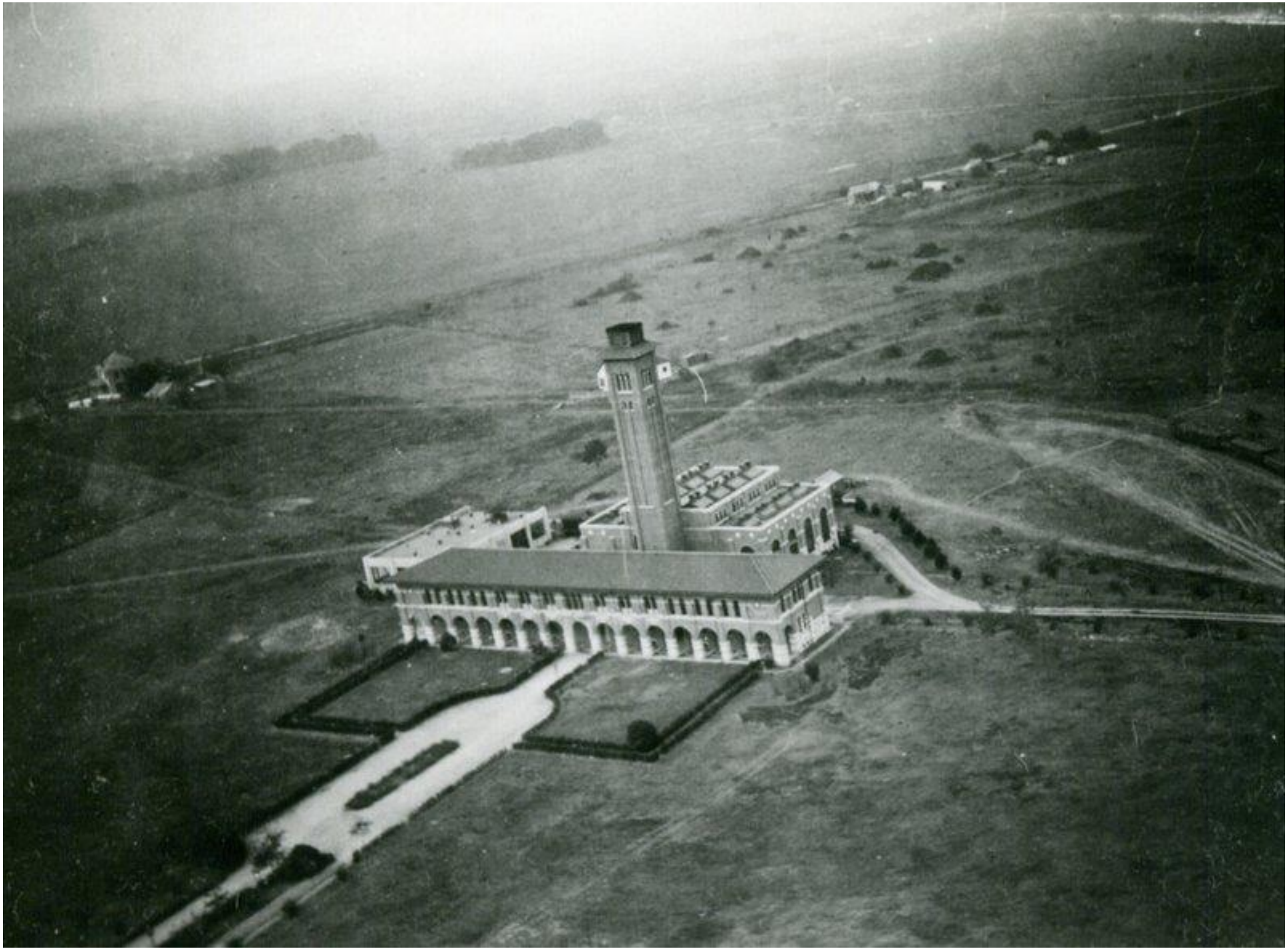
So what about “expand co-generation”…?

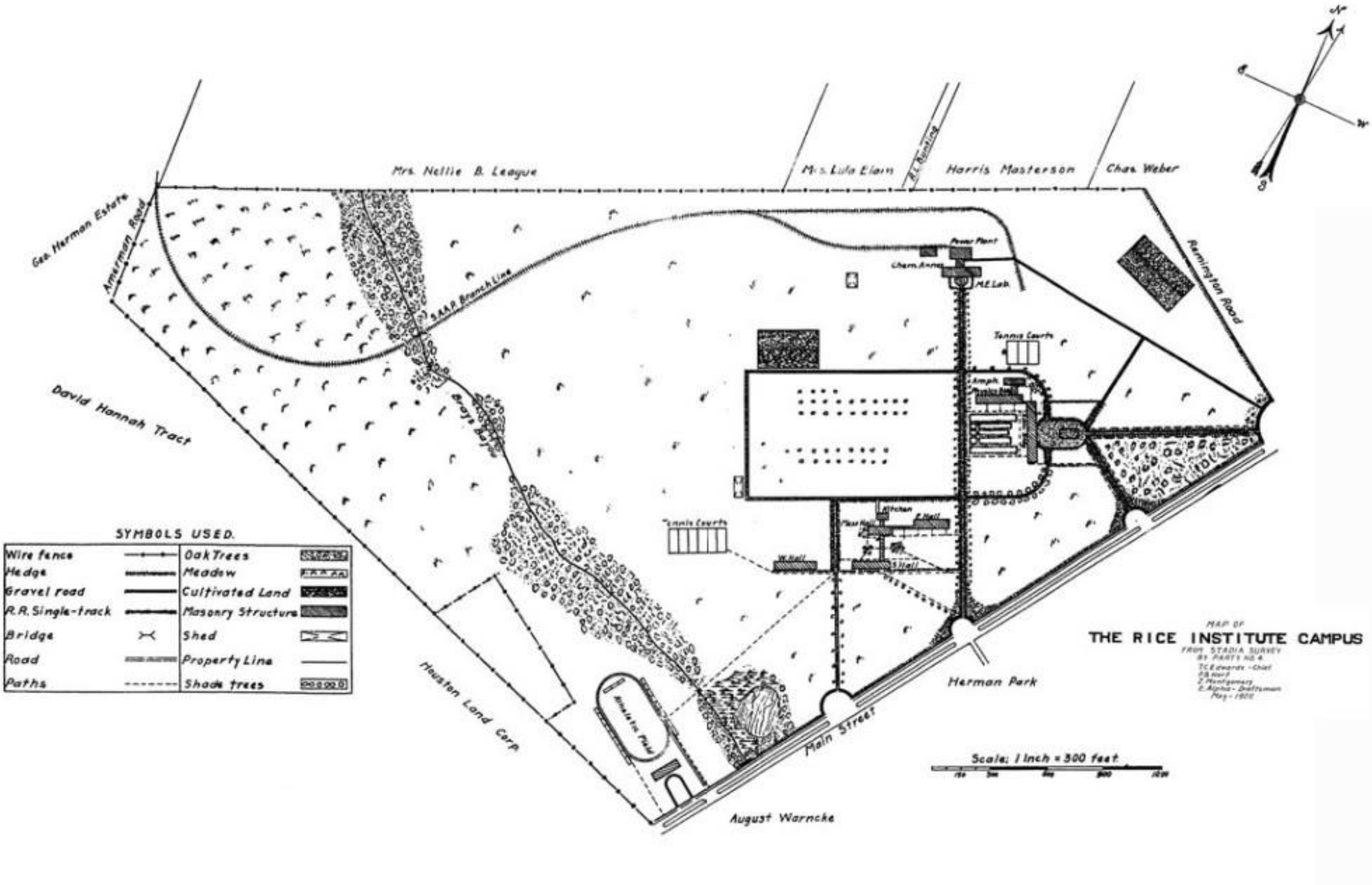
20th Century Energy Transitions at Rice


May 1912


E.K. Irish
Photo Co
TUN "C" NEAR ENTRANCE TO ADMINISTRATION BLDG.



Source: http://timeline.centennial.rice.edu/site_media/uploads/images/2011-01-10/Mech_Lab_Power_House_1912_jpg_800x700_q85.jpg



Source: http://www.houstonarchitecture.com/haif/topic/21488-institute-spur/


THE TEX
SCHLUETER
HOUSTON.

SHIPMENTS OF FUEL OIL

Date on Ticket	Gallons	Amount Paid
9-1-24	10,670	$ 417.73
9-6-24	8,258	325.84
9-16-24	10,670	417.73
10-1-24	10,670	392.33
10-9-24	10,670	392.33
10-27-24	10,670	392.33
11-3-24	10,670	392.33
11-13-24	10,670	455.84
11-22-24	10,670	455.84
11-29-24	8,247	354.88
12-3-24	10,670	455.84
12-13-24	10,670	455.84
12-20-24	8,246	354.83
12-27-24	12,035	512.70
1-3-25	12,079	514.55
1-10-25	10,668	455.75
1-17-25	10,670	455.84
1-17-25	8,258	355.34
1-28-25	10,668	455.75
1-31-25	10,670	519.35
1-27-25	12,042	653.20
2-6-25	10,668	519.25
2-17-25	12,035	655.99
3-6-25	10,668	579.60
3-13-25	12,035	652.84
3-20-25	12,079	655.20
4-2-25	12,042	653.20
4-15-25	12,042	581.52
4-25-25	10,659	515.68
5-1-25	12,035	581.20
5-15-25	12,042	581.52
5-23-25	12,079	583.30
32 cars	346,925 gallons	$15,746.48

Average price = $\frac{15,746.48 \times 42}{346,925}$ = $1.91 per barrel.

68,166 gallons - purch. power.

21st Century Energy Transitions (at Rice and beyond)

5 Forces Changing Electricity Grids

1. Affordable Renewable Electricity

- Unlike oil, coal, or natural gas (i.e. ancient sunlight), the wind and the sun (i.e. current solar income) are inherently free. Cheap photovoltaics and wind turbines are game changers.

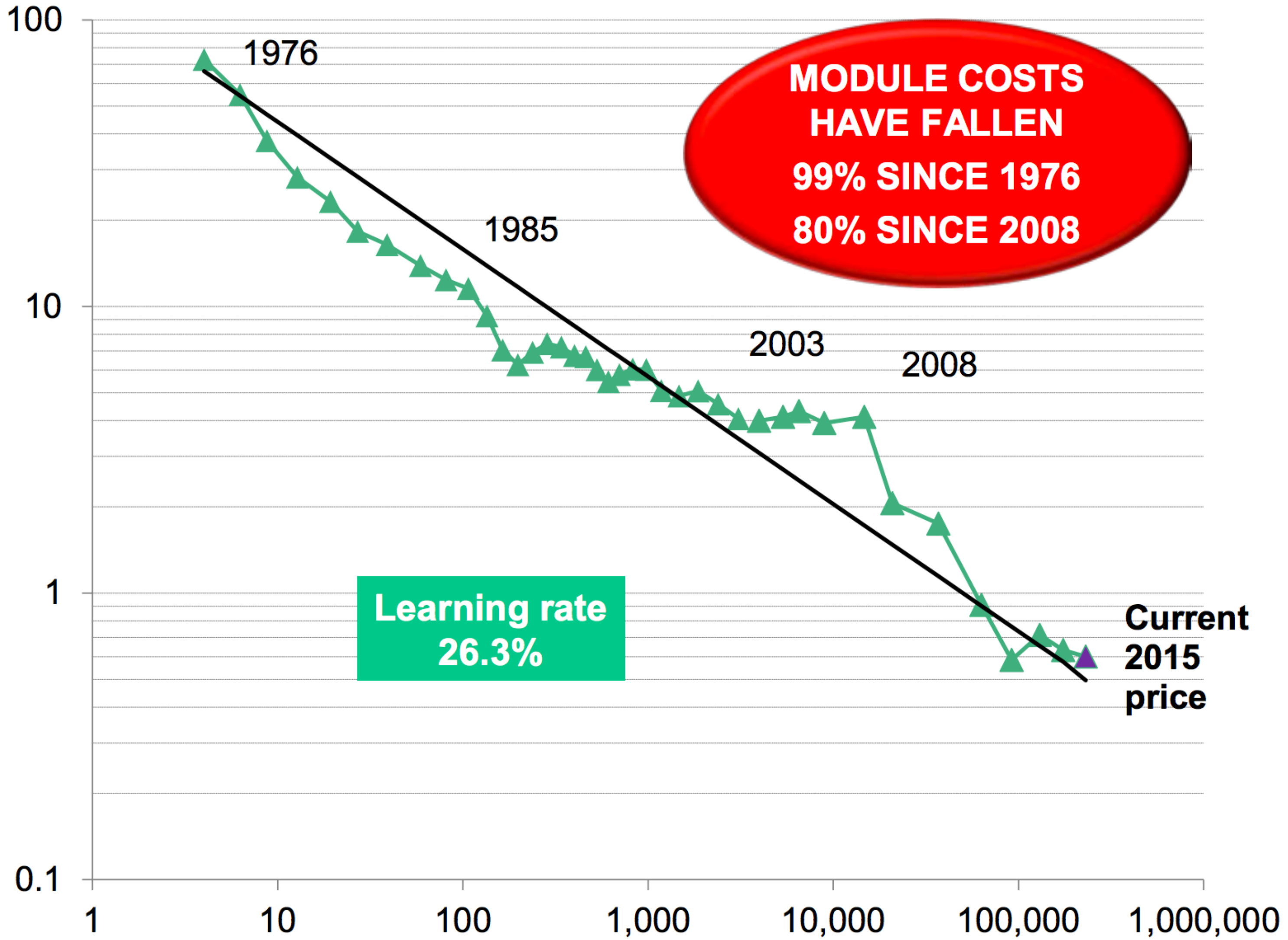
Evidence!

In 2016, renewables accounted for 66% of all new electric generation capacity in the US; natural gas 34%; and coal 0%.

Adapted from Jeremy Rifkin's 5 Pillars of the Third Industrial Revolution; Evidence Source: http://www.ferc.gov/legal/staff-reports/2015/dec-infrastructure.pdf

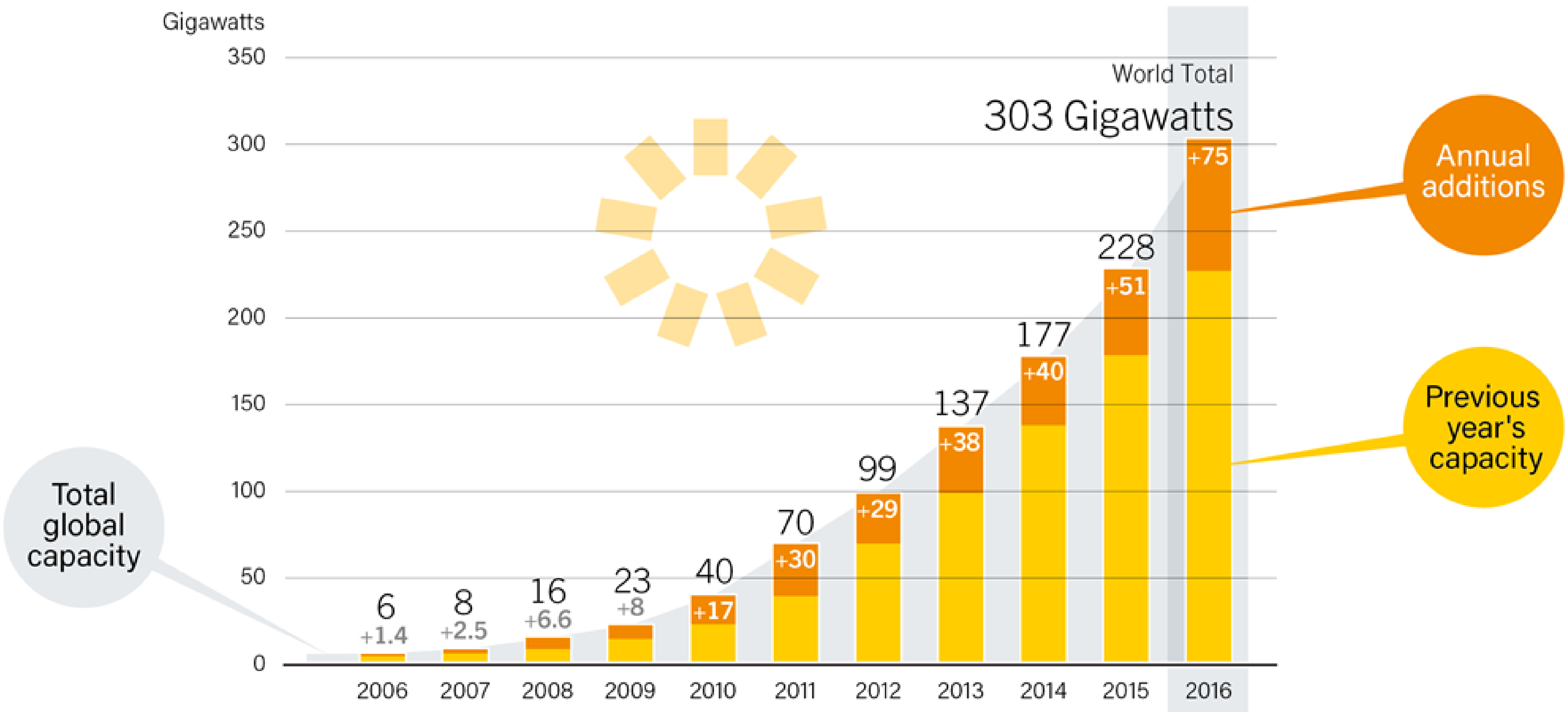
The Beautiful Math of Solar Power

Every time the world's solar power doubles, the cost of panels falls 26%



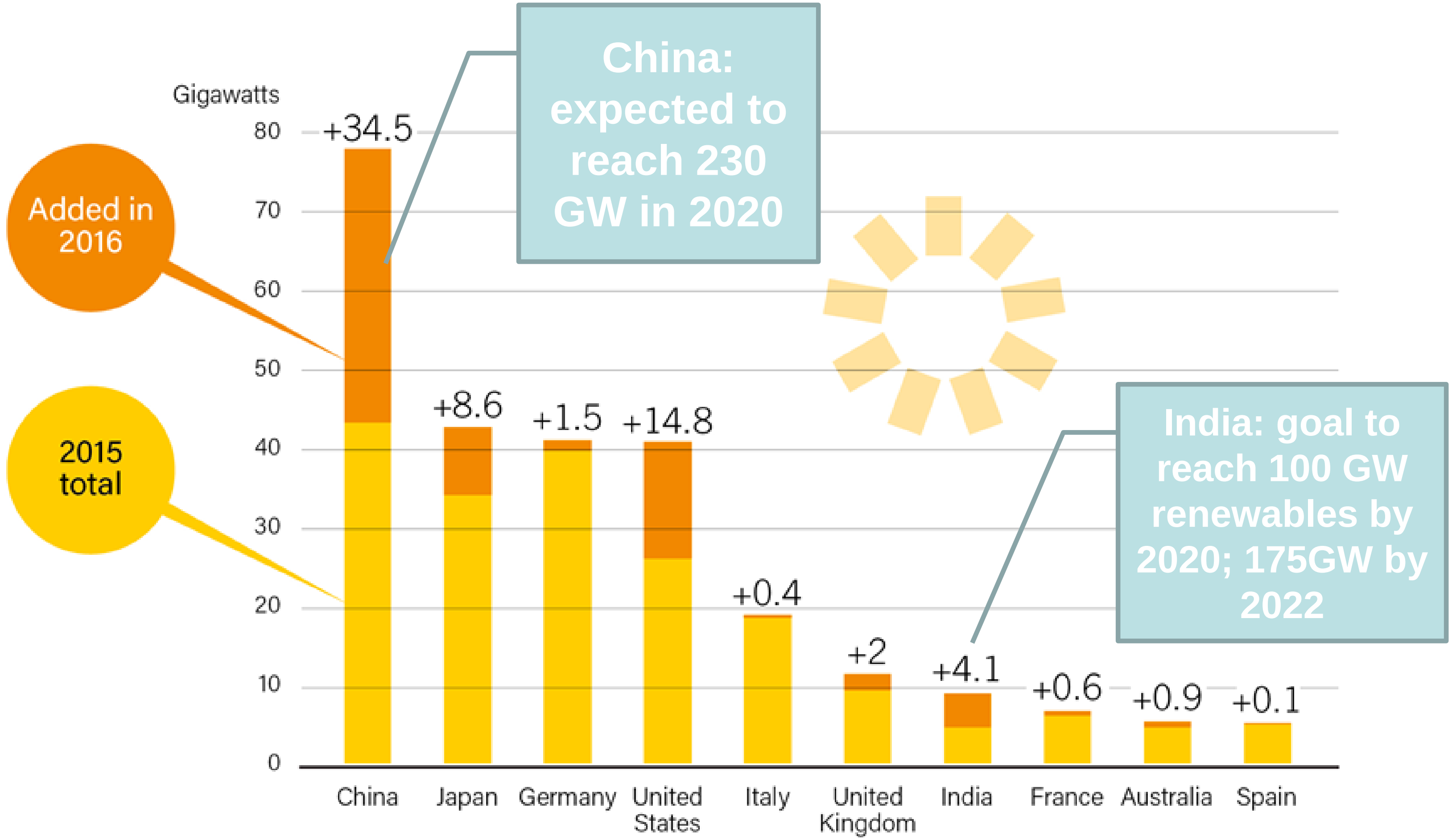
Source: Bloomberg, http://www.bloomberg.com/news/articles/2016-06-13/we-ve-almost-reached-peak-fossil-fuels-for-electricity

Solar PV Global Capacity and Annual Additions, 2006-2016



REN21 *Renewables 2017 Global Status Report*

Solar PV Capacity and Additions, Top 10 Countries, 2016



REN21 *Renewables 2017 Global Status Report*

REN21 Renewable Energy Policy Network for the 21st Century

Rice signs landmark energy agreement with MP2 Energy

JENNIFER EVANS – JANUARY 29, 2015

POSTED IN: CURRENT NEWS

Rice has taken a big bite out of its carbon footprint for 2015 with a landmark energy agreement it recently signed with the power company MP2 Energy.

The one-year agreement will provide approximately 7 percent of the university's purchased electricity from solar power. The solar energy will come from First Solar Inc.'s Barilla Solar Project, which produces 22 megawatts of energy and is located in Pecos County, Texas. Moreover, Rice will be paying the same rates for solar energy, which historically has been much more expensive, as it would for traditional gas- or coal-generated energy.

Rice has signed an agreement to procure electricity generated from solar arrays in West Texas. Thinkstockphotos.com

"We were able to specifically procure renewable energy — in this case, electricity generated from solar arrays in West Texas — with no increase in cost," said Richard Johnson '92, director of Rice's Administrative Center for Sustainability and Energy Management.

According to MP2 Energy, this is the first time off-site solar power is being delivered to a commercial entity on a short-term contract, without state or utility incentives in a deregulated market.

Johnson credits Rice's Eric Valentine, energy manager, and Mark Gardner, manager of energy strategy and utility program development, for their persistence in pursuing this opportunity.

He said they recognized that if Rice switched to a procurement model in which the university bought its electricity in hourly increments with all the components of the pricing presented transparently — rather than daytime, nighttime and weekend blocks that mask the true market price of electricity — Rice could better manage its energy consumption and spending. "Finding a retail electric provider that offered such a procurement model was not easy, but we found an excellent partner in MP2 Energy," Johnson said.

"This deal demonstrates that solar is truly becoming competitive in the most competitive electricity market in the U.S.," said Jeff Starcher, CEO of MP2 Energy. "We applaud Rice for taking a leadership role in embracing true renewable energy."

Rice Greens its Electricity Procurement…
at No Increase in Cost!

5 Forces Changing Electricity Grids

1. **Affordable Renewable Electricity**

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2. **Net-Zero or Energy-Exporting Buildings**

   - The power plant is no longer a separate entity. Buildings themselves can now generate and even export power. Power generation is becoming decentralized!

Adapted from Jeremy Rifkin's 5 Pillars of the Third Industrial Revolution

Net Zero Energy Walgreens: Evanston, IL

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Rice University Solar: Jones College, South Wing

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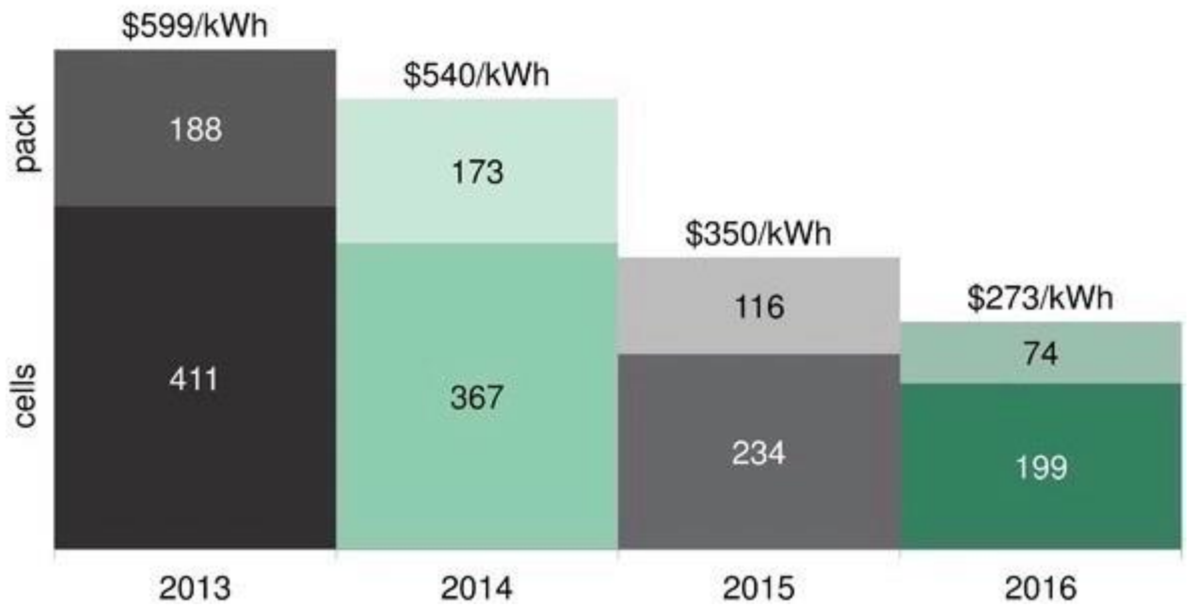
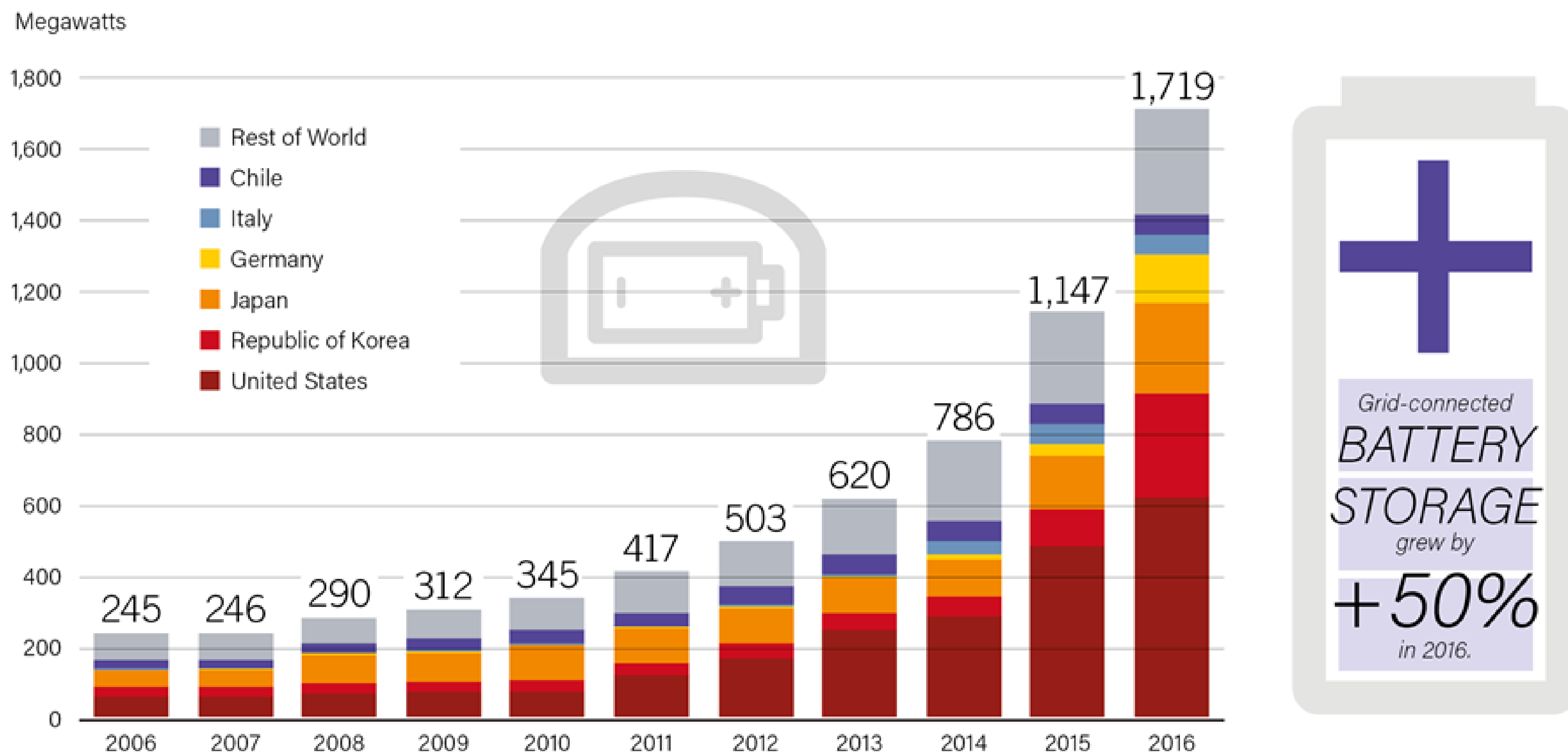
Battery Prices Are Falling Fast



Global Grid-Connected Stationary Battery Storage Capacity, by Country, 2006-2016



Thermal Storage in the Texas Medical Center (tallest in the world!)

Source: http://www.burnsmcd.com/Resource_/Project/2041/AdditionalImage4/IND-TECO-04GAL.jpg

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4. **Internet Meets Power Grid (i.e. the Energy Internet)**

   - Smart metering and the internet enable power grids to more closely resemble the "sharing" economy. Think Uber for electricity!

Adapted from Jeremy Rifkin's 5 Pillars of the Third Industrial Revolution

The Sharing Marketplace

Platform	"Excess Capacity" in Marketplace	Payment Model
UBER EVERYONE'S PRIVATE DRIVER™	Open seat(s) in car	Paid upon completion of trip (dynamic rates)
airbnb	Open room(s) in dwelling unit	Paid when room is rented
ERCOT	Available megawatts from idle generators and any loads that can be shed or fuel-switched on-demand	Paid regardless of whether called-upon to perform (but must pass tests and meet requirements when asked to perform)

2016 Electricity Program Results

Program	Time Period	Revenues	Notes
ERS-30	FEB '16 -MAY '16	$64,028	Actual – check received
	JUN '16 -SEPT '16	$16,183	Actual – check received
	OCT '16 -JAN '17	$60,176	Actual – check received
CenterPoint Load Share	Summer '16	$166,765	Actual – check received
	Curtailment Programs total	**$307,152**	
4CP Management	Summer '16	$132,000	Estimated credits to '17 billing
	4CP Management total	**$132,000**	Savings
	Total Curtailment + 4CP	**$439,152**	

Combined Revenues and Savings to Rice from June 2012 thru Dec 2016: $1.84 Million

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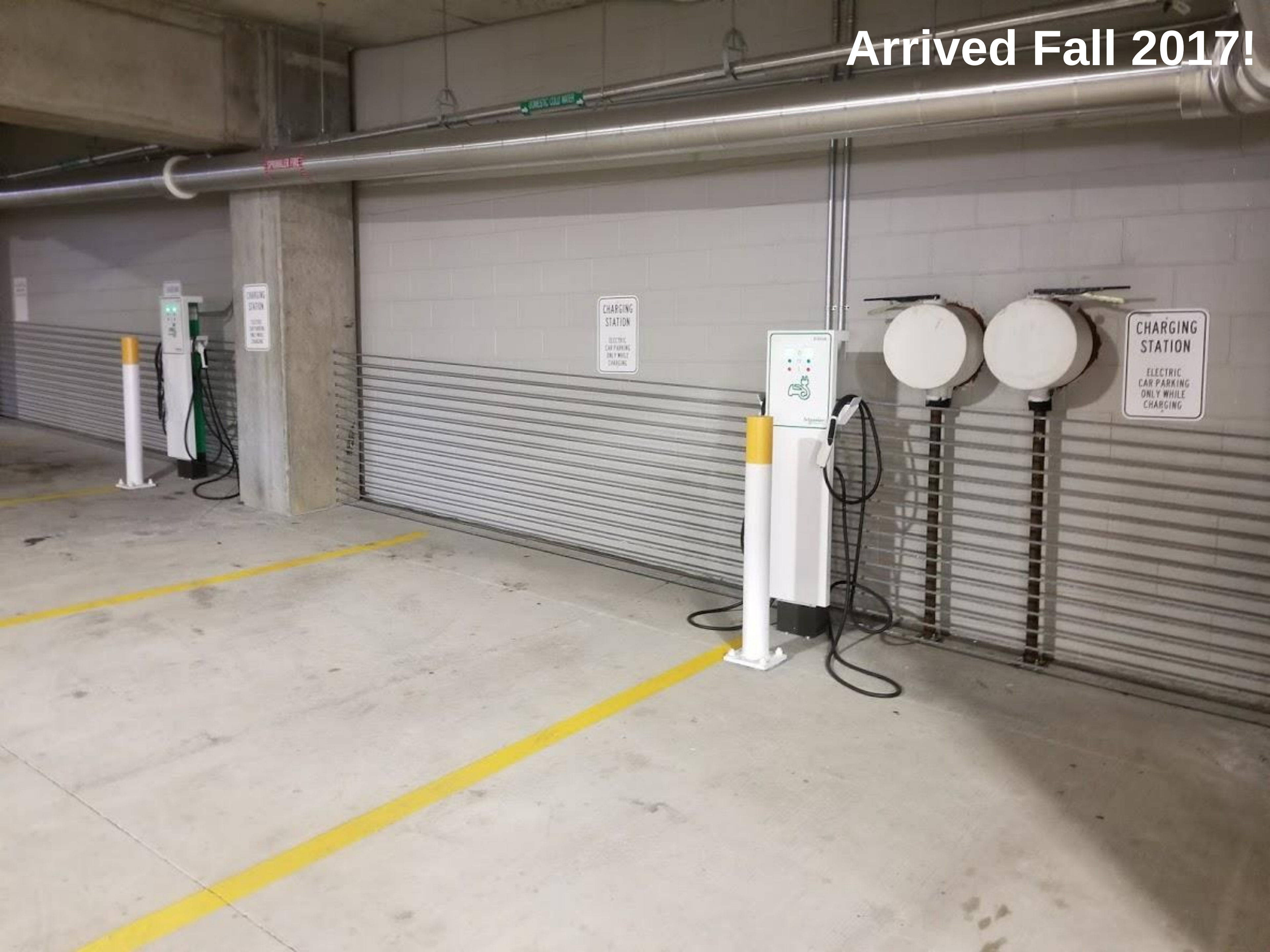
5. **Electric Vehicles**

   - Transportation will become increasingly electric, and batteries within those vehicles will function like smart meters and "share" electricity.

Adapted from Jeremy Rifkin's 5 Pillars of the Third Industrial Revolution


Arrived Fall 2017!
CHARGING STATION
ELECTRIC CAR PARKING ONLY WHILE CHARGING


TESLA

Twilight for Fossil Fuel Vehicles?

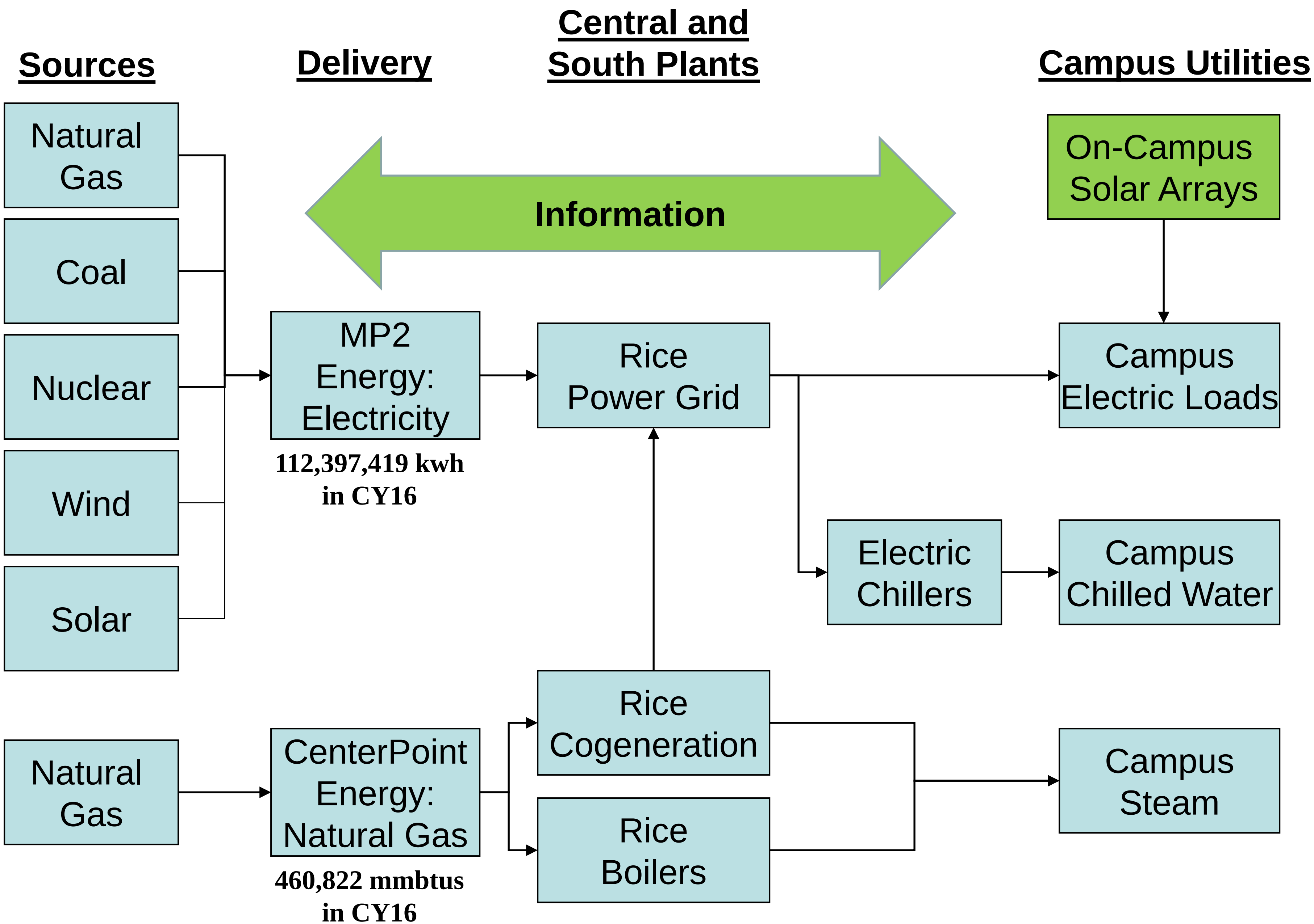
Norway	Only electric and plug-in hybrid cars can be sold by 2025
France; United Kingdom	Sale of gas and diesel vehicles banned by 2040
Germany; The Netherlands	Bans under consideration
China	"Working on a plan" to ban the production and sale of vehicles powered only by fossil fuels
India	Goal for every vehicle to be electric by 2030
Countries w/EV sales targets	Austria, Denmark, Ireland, Japan, the Netherlands, Portugal, Korea, Spain
Volvo	Will only produce electric and hybrid vehicles by 2019
Renault	Half of vehicles sold will be electric or hybrid by 2022

"Banning sales of diesel and gasoline vehicles by 2040 is a bit like banning sales of horses for road transportation by 2040: there won't be any to ban."

-- Tony Seba, Stanford University

Now and Beyond

Rice Energy Flow Chart, circa 2017



A Few Thoughts About RICEMaP

- **RICEMaP should be viewed as a starting point.**
- **The initial focus on building- and plant-level efficiency measures was the right start.**
- **Be ready! Fast payback projects require staff to manage them!**
- **The infrastructure "mindset" of the plan did not fully appreciate the energy transition that was already underway.**
- **In 2012-13, we were in the midst of changing our energy procurement strategy; we should have completed that process before launching RICEMaP.**
- **Purchasing RECs does not necessarily result in actual carbon reductions on the grid, and as such is a questionable strategy for a Climate Action Plan.**

Rice Energy in the Future: A Few Thoughts

- **We need to set aggressive building-level energy targets and manage to those targets.**

- **Our long-term renewables strategy will need to meet the "additionality" threshold (i.e. did the project actually result in greenhouse gas emissions reductions).**

- **Our energy conservation dollars will increasingly align with planned spending on deferred maintenance.**

- **We are seriously questioning whether we would replace our cogeneration turbines once they reach the end of their useful/economic lives.**

- **We need to be prepared for: storage, cheap renewables, fine-grained control (internet of things) possibly tied to price response, many more electric vehicles, a tsunami of data, an electric and communications infrastructure that supports this…**

Questions?

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Web: http://sustainability.rice.edu

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