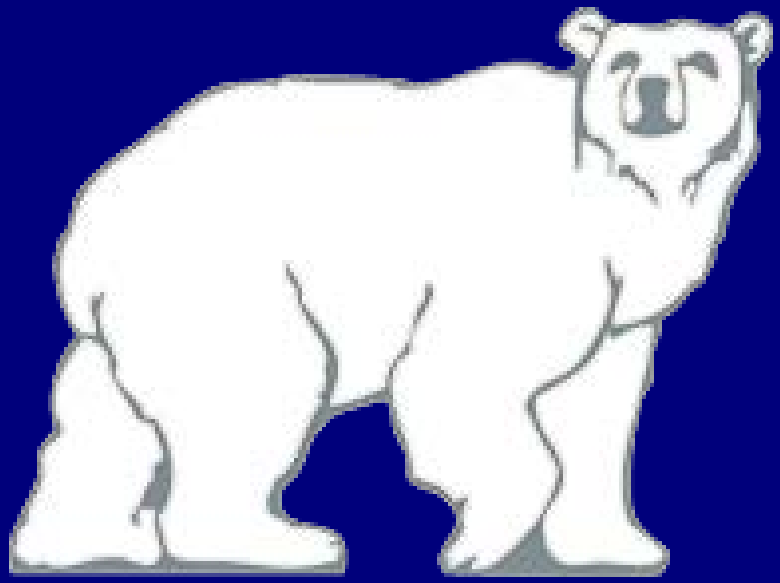
White Bear Lake
City Council Meeting

August 15, 2018



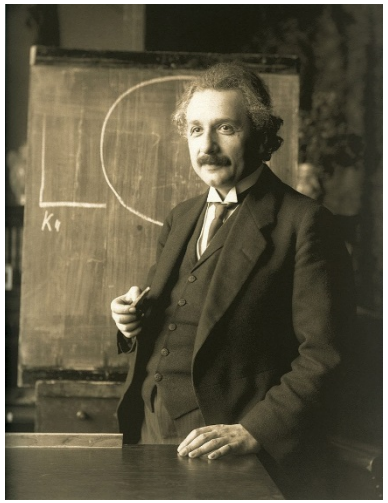
Solar Power

Solar History

1839: French physicist Alexander Edmond Becquerel discovered the "photovoltaic effect" (creation of an electrical current in a material upon exposure to light).

1883: American inventor Charles Fritts created the world's first "real" working solar module using panels coated with selenium.

1905: Albert Einstein wrote a paper explaining the process of how light produces electricity, for which he won the Nobel Prize in physics in 1921.

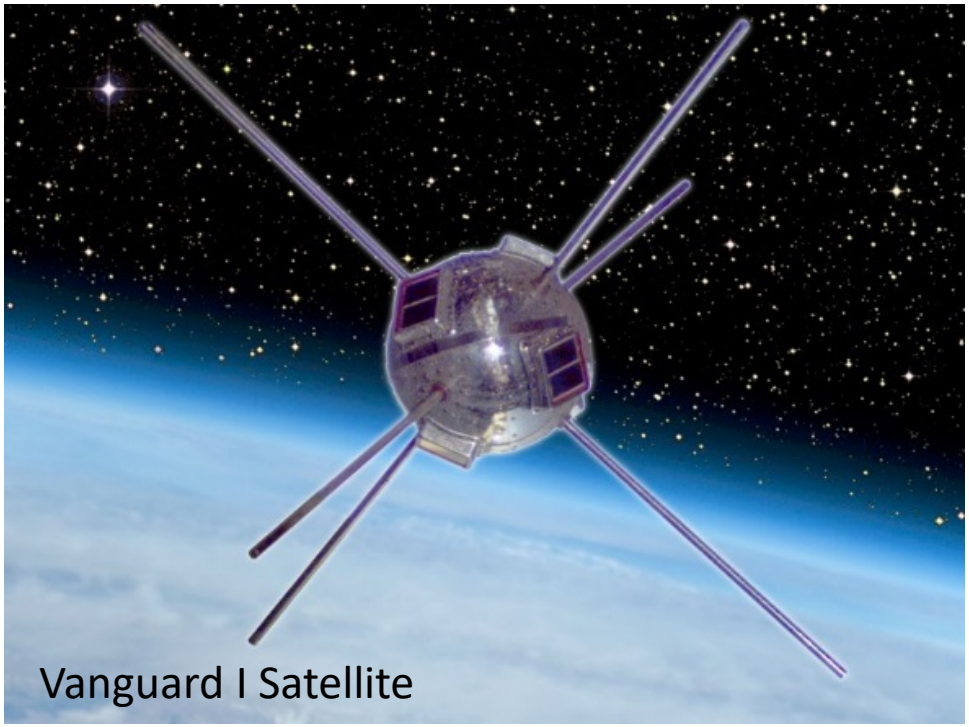


Becquerel's and Einstein's research formed the basis of future developments in solar technology.

Solar History

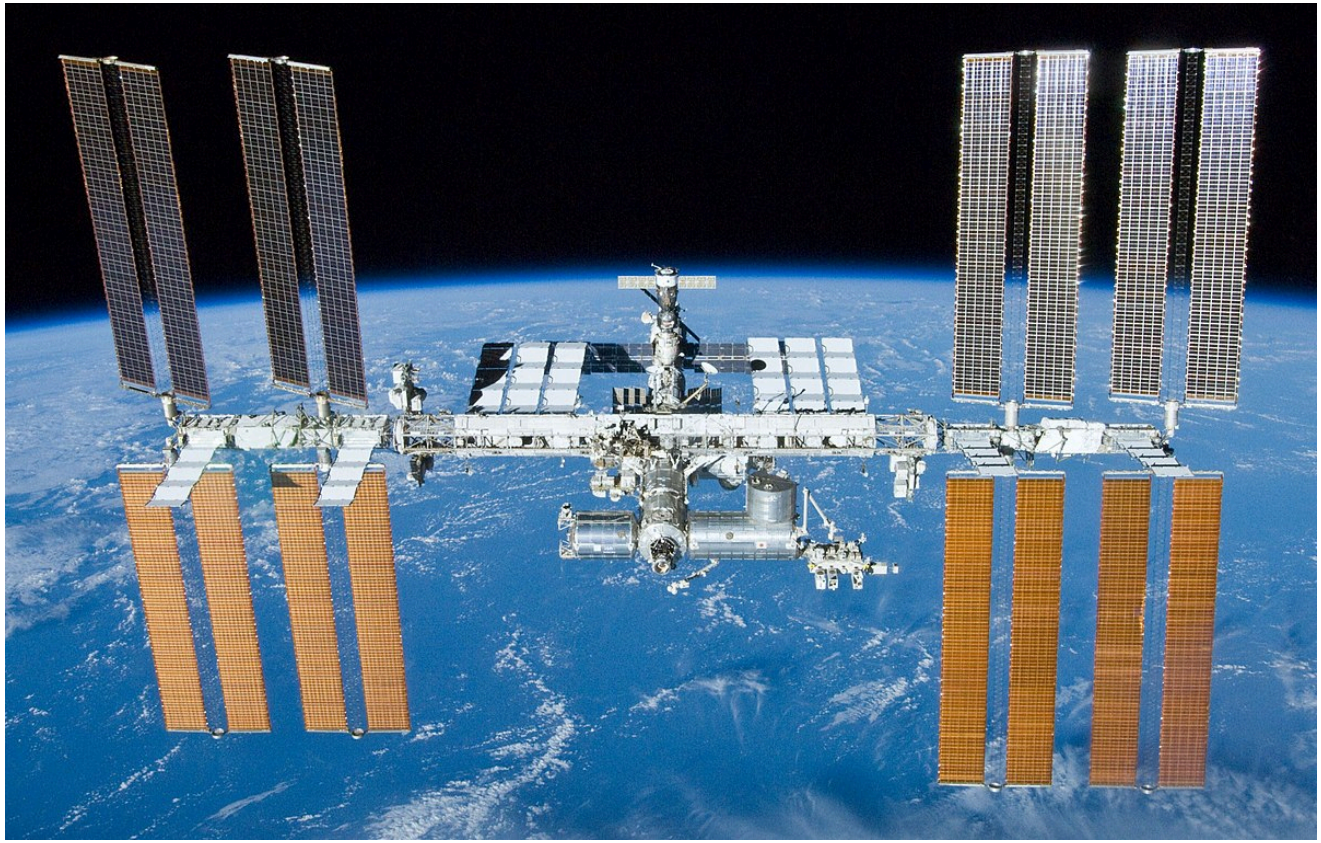
1954: The modern photovoltaic (PV) cell was developed by Bell Labs using silicon. At $300 per watt, solar power was too costly for most commercial use. The U.S. military funded research on PV technology to power satellites in the 1950s.

1958: The U.S. Naval Research Laboratory launched Vanguard I, the first spacecraft to use solar panels. By the late 1960's solar power was standard for powering almost all space satellites.



Vanguard I Satellite

Solar History



International Space Station
launched in 1998

Solar History

1970's:

- Dr. Elliot Berman designed a lower cost solar module by refining manufacturing techniques and by using a less pure grade of silicon, bringing the price down from $100 per watt to around $20 per watt. His research was funded by Exxon Corporation to power lights on off-shore oil rigs.

- The oil crisis in the early 1970's led Congress to pass the "Solar Energy Research, Development and Demonstration Act of 1974". The act also created the Solar Energy Research Institute (National Renewable Energy Laboratory) to conduct research and facilitate the industrial use of solar power.

- In 1978 the first iteration of a feed-in-tariff was implemented with the National Energy Act (NEA) to encourage energy efficiency and to develop new energy resources.

Solar History

1980's and early 1990's:

- Most PV modules in this time period were used in stand-alone power systems or powered consumer products such as watches, calculators and toys.

Mid 1990's to today

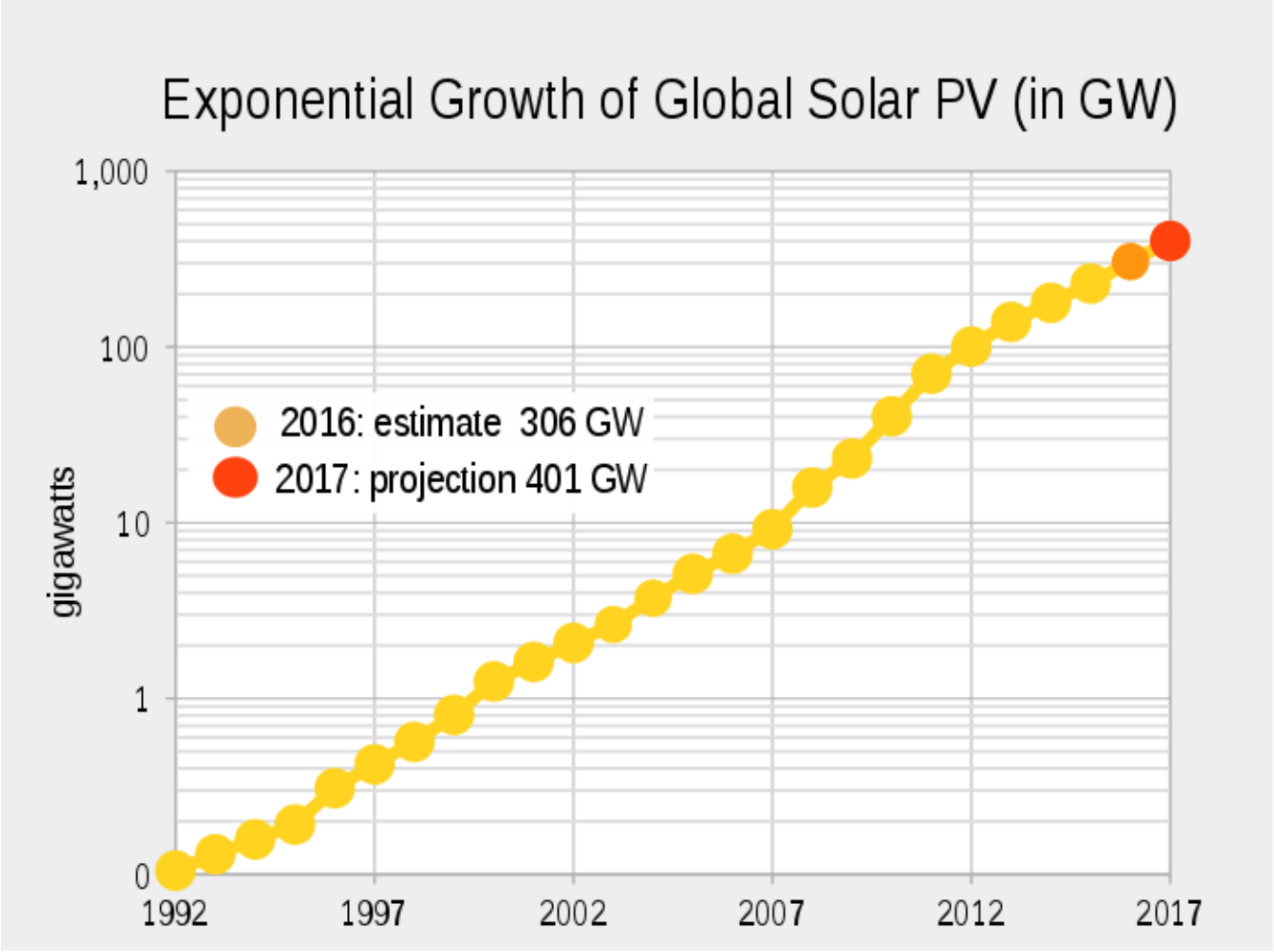
- Evolved from a niche market of small scale applications to a mainstream electricity source.

- By 1995 industry efforts focused increasingly on developing grid-connected rooftop PV systems and power stations.

- By 1996, solar PV capacity in the U.S. amounted to 77 megawatts – more than any other country in the world at the time.

Solar History

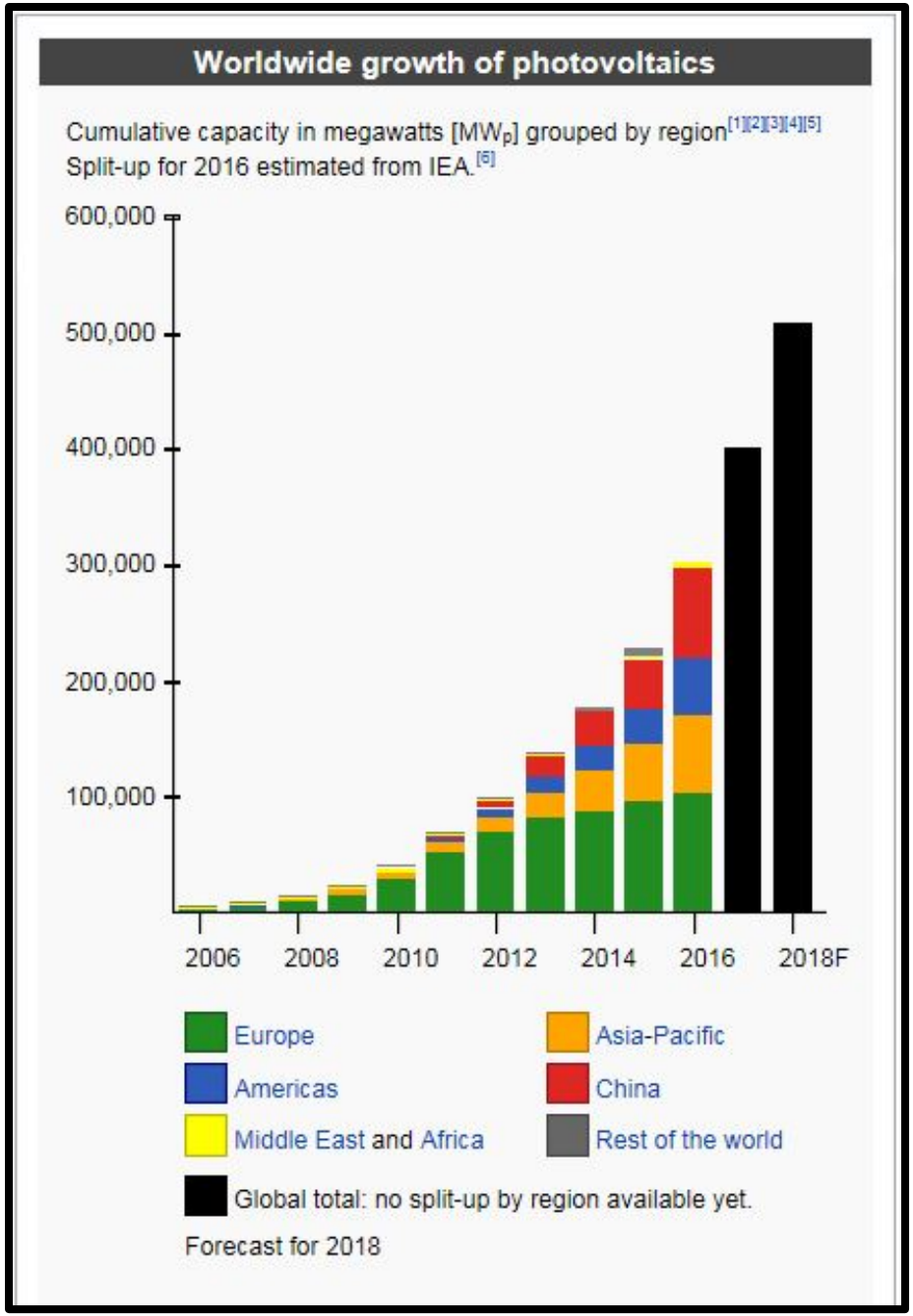
Worldwide growth of photovoltaics has been on an exponential curve since 1992



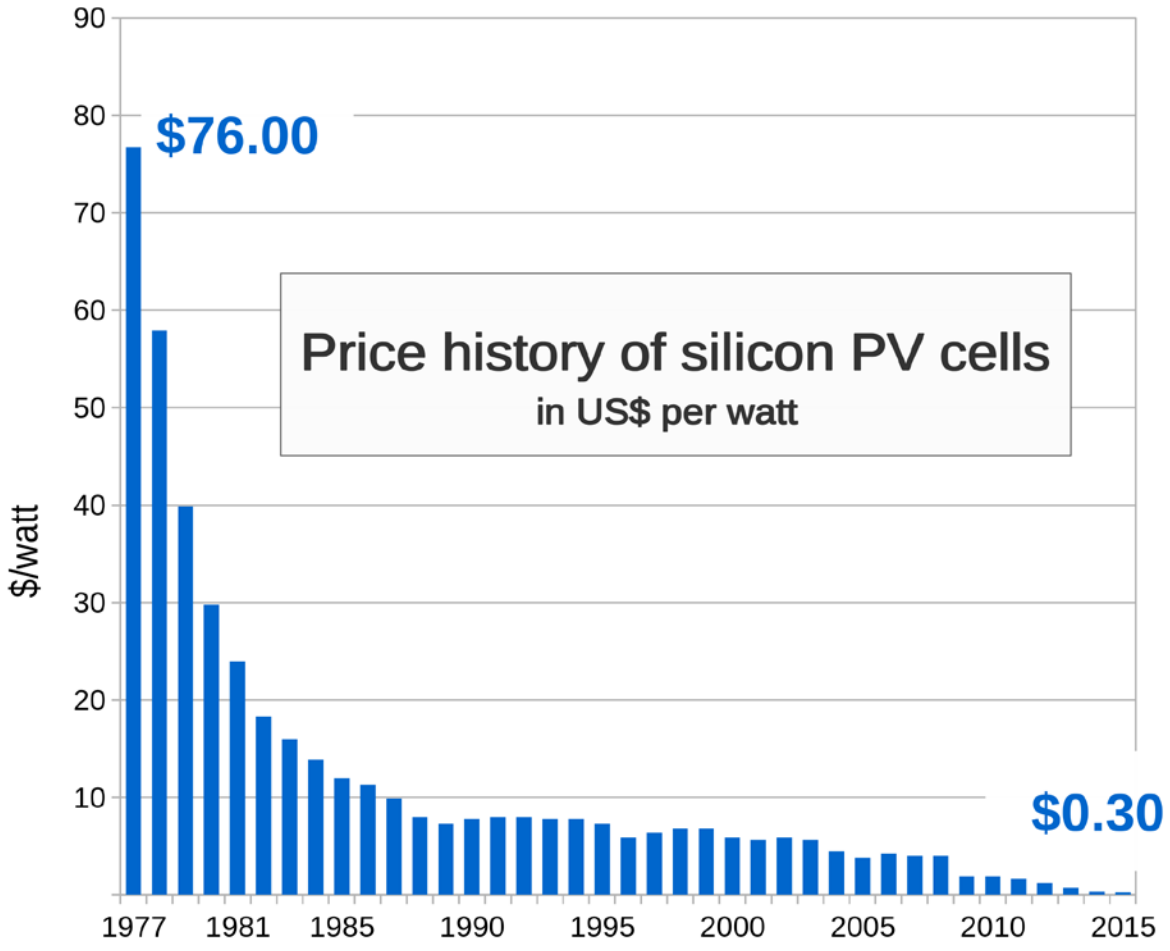
Japan bypassed the US as the world's leader of produced solar electricity until 2005, when Germany took the lead.

In 2015, China became world's largest producer of PV power, and in 2017 became the first country to surpass 100 GW of cumulative installed PV capacity.

For several years, growth was mainly driven by Japan and pioneering European countries. As a consequence, cost of solar declined significantly.



Solar History



Source: Bloomberg New Energy Finance & pv.energytrend.com

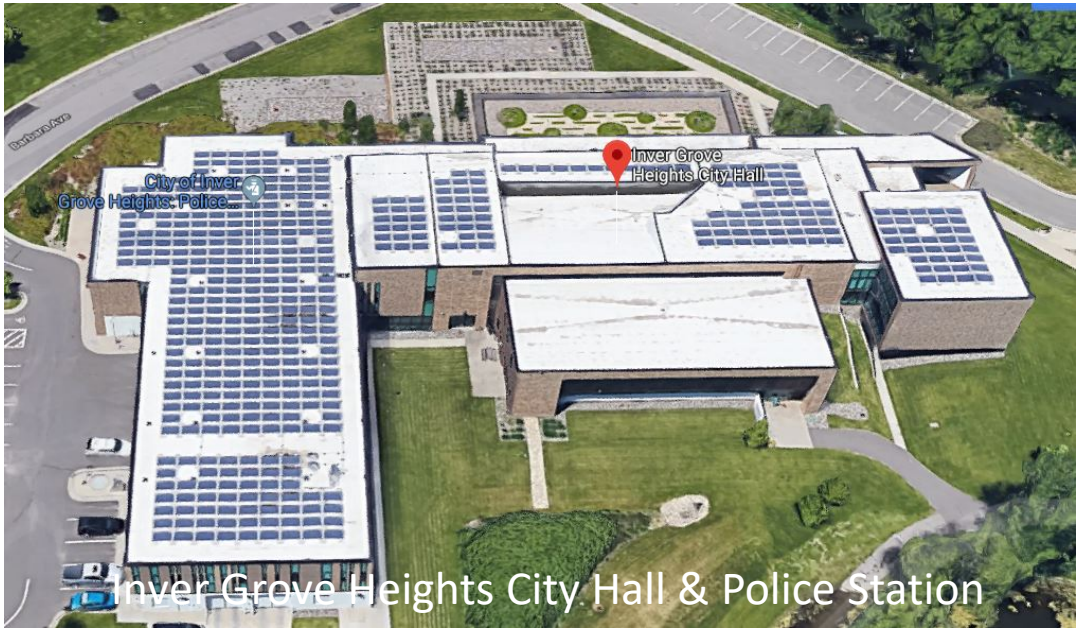
Drop in price due to:

- price of the raw material polysilicon dropped
- increasing efficiency of solar cells
- manufacturing technology improvements
- economies of scale
- intense competition, leading to module oversupply

Solar History

2000's

- Congress passed the Energy Policy Act of 2005 as an attempt to combat growing energy problems. The Act changed energy policy by providing tax incentives and loan guarantees for energy production of various types (both non-renewable and renewable), introducing for the first time a 30% investment tax credit (ITC) for residential and commercial solar energy systems.



Inver Grove Heights City Hall & Police Station

Solar History

2000's

- The 30% federal ITC was set to expire at the end of 2007. A series of extensions pushed the expiration date back to the end of 2016, but experts believed that an additional five-year extension would bring the solar industry to its full maturity. Congress passed a spending bill in late December 2015 to extend the solar tax credit for another 5 years:
    - Through 2019: 30%
    - 2020: 26%
    - 2021: 22%
    - 2022 onwards: 10%

- Out of all energy specific federal subsidies in 2016 (includes both non-renewable and renewable energy), 45% was allocated for renewables, of which approximately 1/3 was solar specific.

Source: US Energy Information Administration, financial interventions and subsidies

Is Solar Right for Us?

1) Financing structure

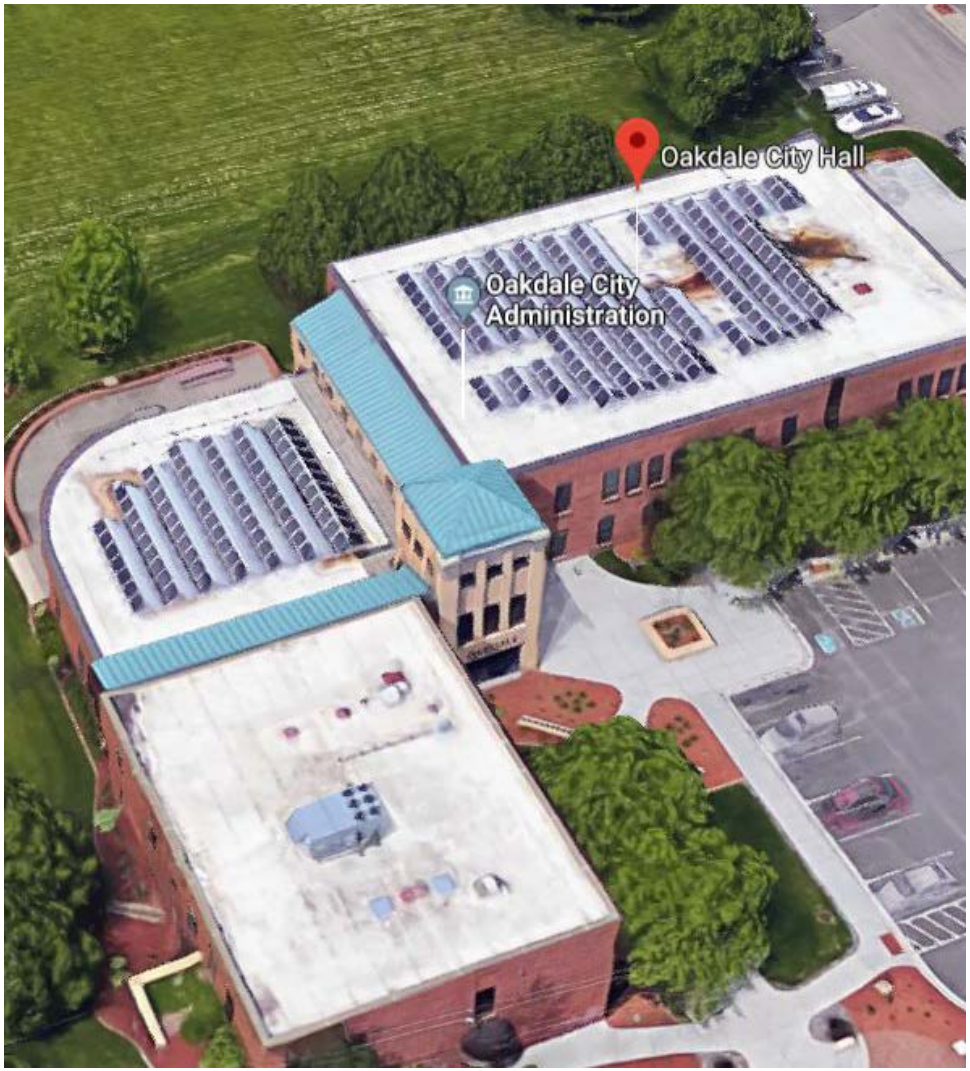
2) Suitable sites

3) Maintenance

4) Disposal

5) Energy savings

6) Risks



Oakdale City Hall

Is Solar Right for Us?

1) Financing Structure

Third Party Advantages

- Ability for a tax exempt entity to benefit from savings passed on from federal tax credits
- No upfront costs
- No operating and maintenance responsibilities
- Predictable cost of electricity
- Path to ownership

Third Party Challenges

- Long term contract
- Receive only a percentage of savings
- Limited control over project design
- Purchase price uncertainty

Direct Purchase Advantages

- Ability to use cheap public debt
- Full control over project design
- Typical project management:
  design, bid, build
- Receive all energy generated from array

Direct Purchase Challenges

- Public entity cannot monetize the value provided by federal tax credits
- $137,500 per 40kW system
- Project management requirements
- Ongoing maintenance

Solar Examples

Who is doing third-party solar?

- Annandale Public Schools
- Becker High School
- Burnsville-Eagan-Savage School District
- Chippewa Middle School in North Oaks
- Chisago Lakes School District
- Chisago Primary School
- City of Brooklyn Park
- City of Champlin
- City of Columbia Heights
- City of Cottage Grove
- City of Crystal
- City of Falcon Heights
- City of Golden Valley
- City of Inver Grove Heights
- City of La Crescent
- City of Lindstrom
- City of Maplewood
- City of Minneapolis
- City of Oakdale
- City of Red Wing
- City of Rogers
- City of Scandia
- City of Shoreview
- City of St. Cloud
- City of St. Paul
- City of Woodbury
- Farmington Schools
- Forest Lake Public Schools
- Holdingford Public Schools
- Hopkins High School
- Lester Prairie Water Treatment Center
- Minneapolis Public Schools
- Rockford Area Schools
- St. Cloud School District
- Waconia Public Schools

Source: CERTs

Solar Examples

Who has done direct purchase?

- City of Hutchinson
- City of Minneapolis
- City of St. Louis Park
- City of St. Paul
- Hennepin County
- Minneapolis Parks
- Mounds View Public Schools

Source: CERTs

Minneapolis Convention Center – 600kW
Minneapolis Fire Station 6

Is Solar Right for Us?

1) Financing Structure (Third Party Agreements)

City's Responsibility

- Property and Casualty Insurance (rider on existing insurance)
- Staff and legal time to review contract

Third Party Responsibility

- System layout and electrical engineering
- Rebate application, procurement, processing fees
- Utility interconnection agreements
- Purchase and install equipment and electrical connections
- Project management

Summary - Is Solar Right for Us?

2) Suitable Sites

City's Responsibility

- Identify potential sites based on preliminary criteria such as roof type, roof lifespan, and basic yearly energy consumption
- Provide structural plans

Third Party Responsibility

- Solar survey
- Site electrical systems review
- Structural engineering and soil testing
- Analysis of rate plan and total electrical spend and consumption.

Minneapolis Fire Station 4

2) Suitable Sites

- Flat roof with no shading/obstructions
- Roof lifespan
- Energy consumption

Is Solar Right for Us?

3) Maintenance

- No moving parts, very little maintenance needed
- Panel and inverter warranty's
- Panels installed at 10 degree angle, self cleaning
- Made of tempered glass. Engineered for 50mph winds and 1 inch of hail

City's Responsibility

- Responsible for maintenance after contract expires
- Can enter into a maintenance contract with a solar company for $350 per year to monitor the system and conduct two inspections per year.

Third Party Responsibility

- Responsible for operations and maintenance during the length of the contract at no cost to the City.

Is Solar Right for Us?

4) Disposal

- Most panels pass toxicity testing and are regulated as normal solid waste.
- If a solar panel is determined to be hazardous, it can be routed through an electronics recycling program.
- Metals in the solar panel make it likely that they can be recycled. The viability of a recycling program depends on sufficient waste stream. There are not enough decommissioned panels to create a recycling market in the near term.

Source: CERTs

City's Responsibility

- Responsible for disposal after 30 to 40 years.
- Estimated cost in today's dollars is approximately $50 per panel ($4,500 for 40kW).

Is Solar Right for Us?

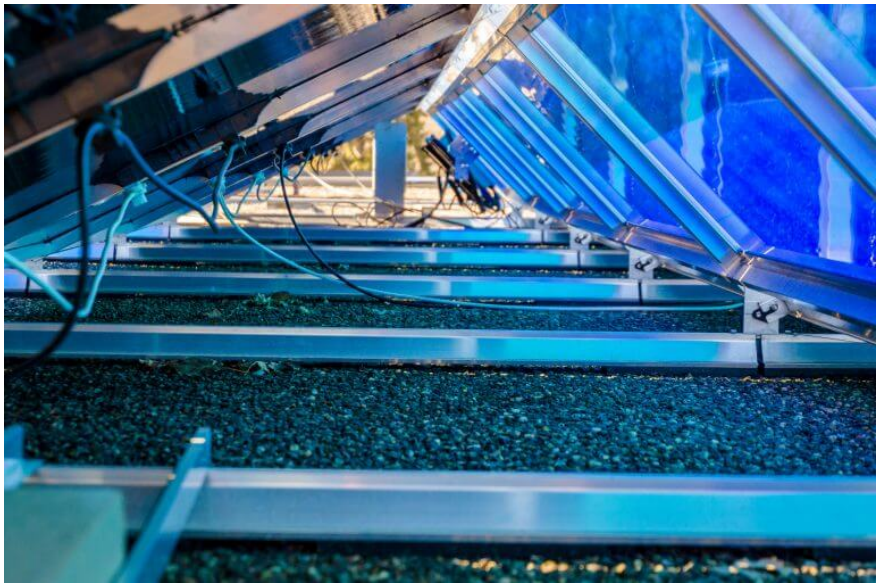
5) Energy savings

- Third party financing structure: approximate 20% savings on energy bills.

- In year one, $4,900 savings per 40kW array. Will go up due to yearly increase in Xcel rates.

City's Responsibility

- Pay third party for energy use through length of contract
- After contract, City receives all energy generated by solar array for free (length of contract varies)



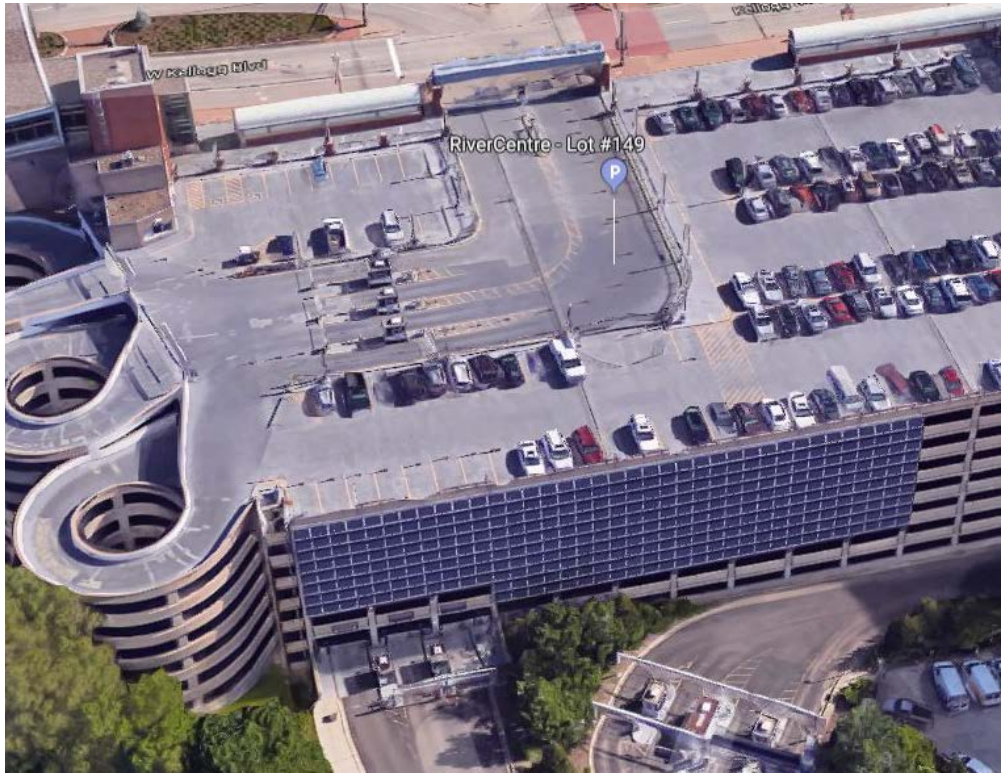
Lindbergh Parking Ramp, Mpls-St. Paul International Airport

Project included a 3MW solar array, replacement of 7,700 metal halide lights, and addition of 4 electric vehicle charging stations. 2016 energy conservation projects and solar array anticipated to reduce utility costs by $644,996 per year.

Is Solar Right for Us?

6) Risks

- Third party financing assumes a fixed increase in utility costs each year.
- Mature technology; low risk of the system being outdated in a few years.
- Purchase price uncertainty at end of contract.



St. Paul RiverCentre

Third Party Contractor

- 20 year capital lease program, w/ option to terminate the lease at year 13. City owns the system.
- Design, installation, financing, and operation.
- Offers a one year lease extension to cover the cost of removing and replacing panels for roof repair.
- Specifies panels that do not contain hazardous materials.
- Preferred solar vendor for the State of Minnesota.

State Solar Master Contract: pre-qualified list of solar installers, screened based on criteria such as:

- ✓ Experience, quality, cost, and diversity & inclusion
- ✓ Ability to do design and engineering work, module installation, and operations & maintenance
- ✓ Install pitched roof, flat roof, or ground mount installations
- ✓ Solar panel warranties and technical efficiencies
- ✓ Construction specifications and electric code & engineering standards

Next Steps

Falcon Heights City Hall and Public Works - 40kW