METHODOLOGY FOR ESTIMATING ROOFTOP SOLAR FEASIBILITY ON AN URBAN SCALE

PROJECT INTRODUCTION

City of Phoenix

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PROJECT INTRODUCTION

- The project is a study of a methodology for implementing rooftop photovoltaics on an urban scale

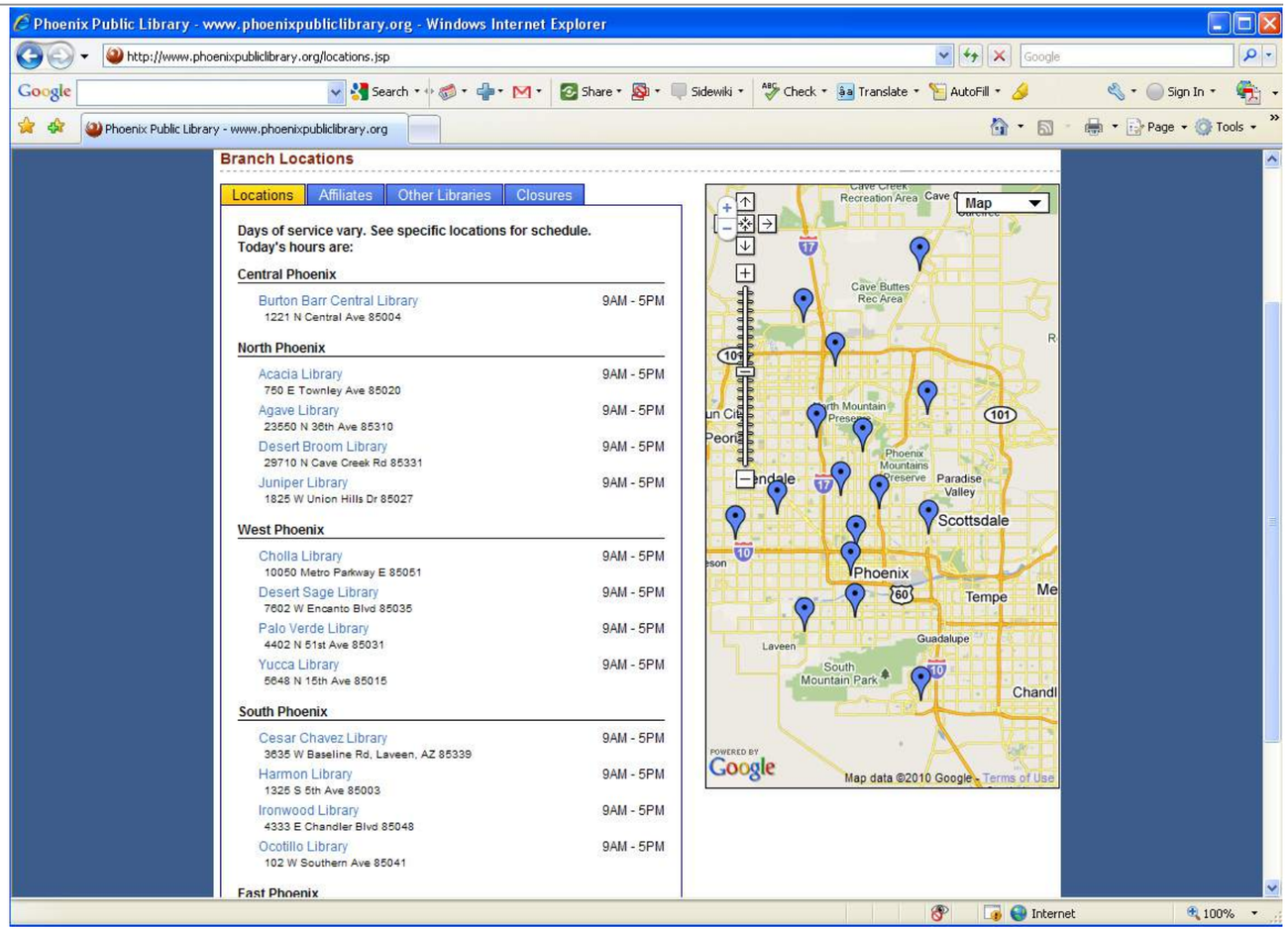
PROJECT INTRODUCTION

- According to US Census data, there are over 200 billion sq. ft. of rooftops in the United States.[1]
- If even 25% of this area is suitable for continuous PV operation the potential installed capacity exceeds over 250,000 megawatts.[2]

PROCESS

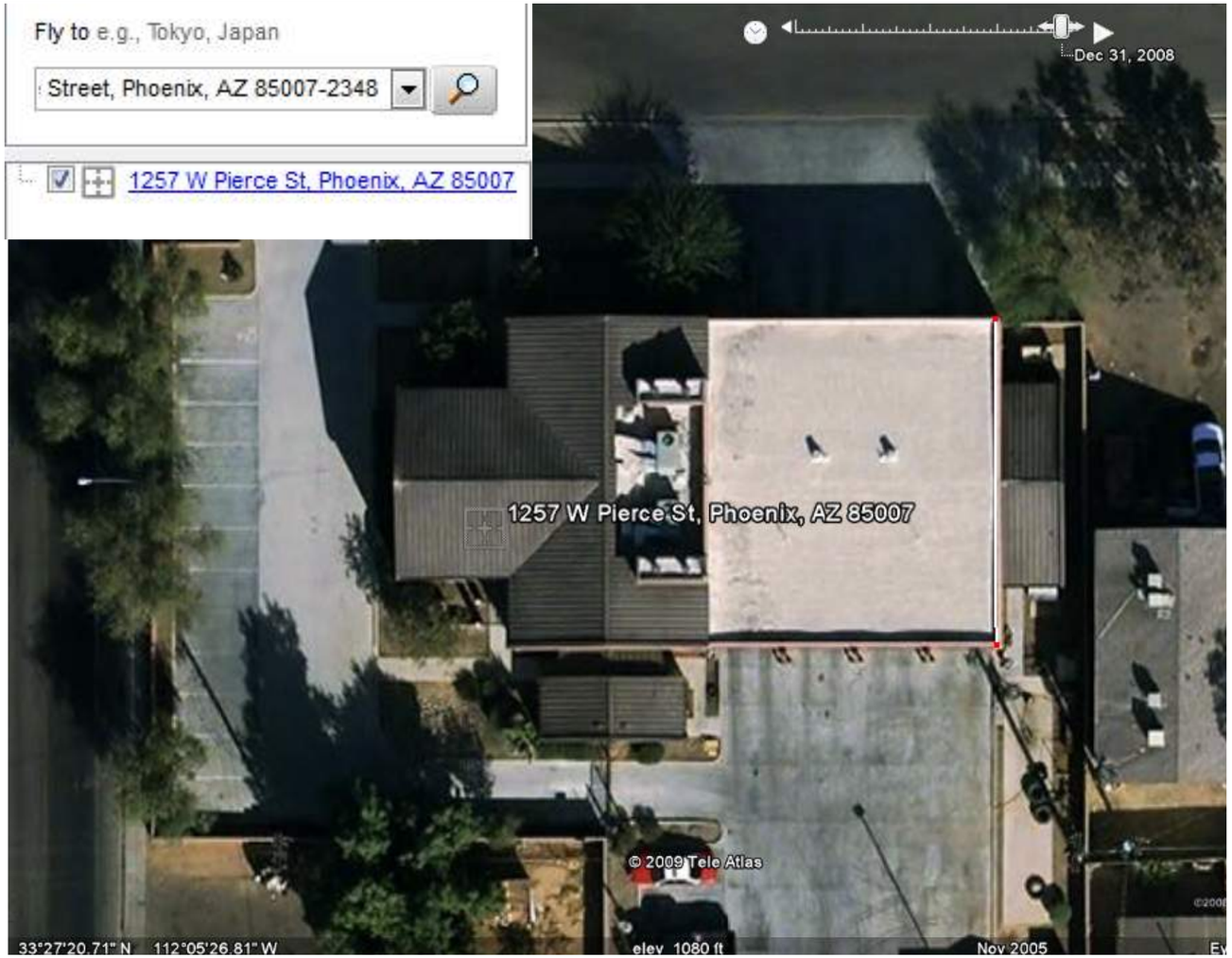
PREPARE A LIST OF CITY BUILDINGS

- Team began by searching the City of Phoenix website to identify city operated buildings
- List was cross-referenced with a list received from the city
- Compiled list identified 364 buildings spread over 475 sq. miles



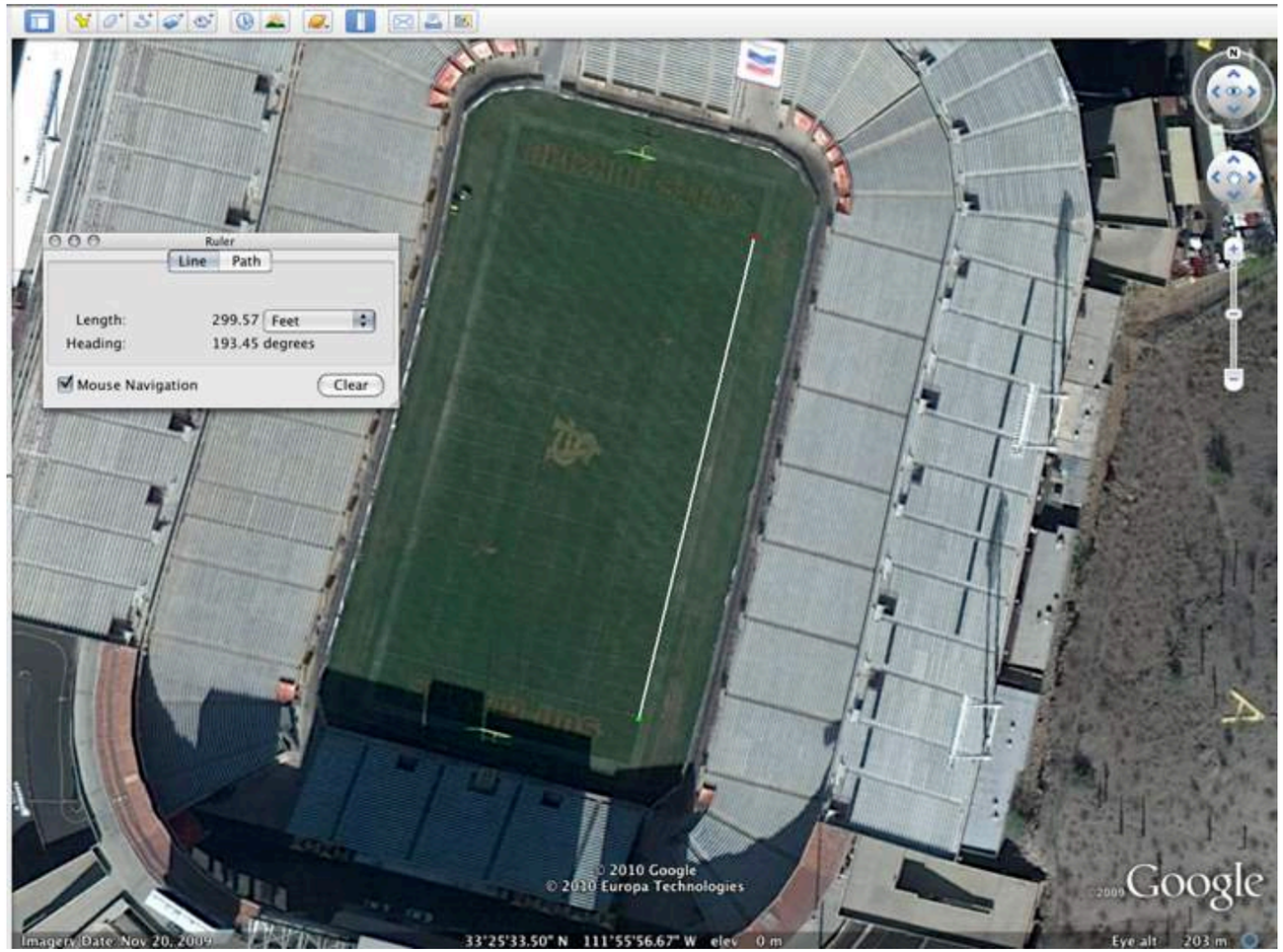
GOOGLE EARTH

- Building addresses were queried by using Google Earth
- Allowed us to see general rooftop conditions and location



GOOGLE EARTH

- Team needed to verify the accuracy of measurements taken in Google Earth



GOOGLE EARTH

- One baseline measurement was acquired from each aerial that allowed the team to scale each building in either AutoCad or Sketch-Up

IMPORTING INTO SKETCH-UP OR AUTOCAD

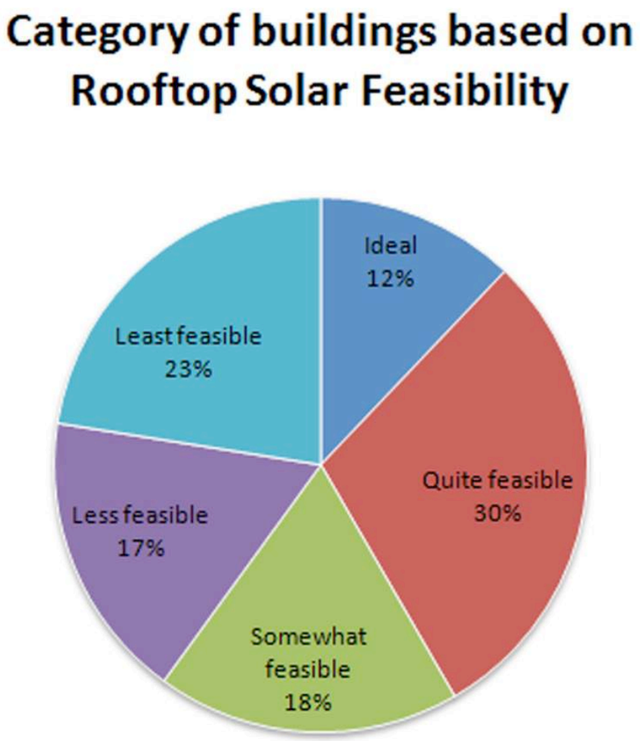
- Areas suitable for photovoltaic installation were highlighted on the scaled image and the respective areas were determined

IMPORTING INTO SKETCH-UP OR AUTOCAD

- Factors Included:
  - Orientation
  - Roof Slope
  - Tree Shading
  - Roof Equipment
  - Parapets
  - Shade from Adjacent Structures

RATING THE BUILDING

- This analysis resulted in a rating for each building on a scale of 1-5
- A total 100 buildings were rated either a 4 or 5



	D	E	F	G	H	I	J	K
1	Link To File	Address	Activity	Notes	Suitability	Roof Area	Roof Area	Roof Area
2								
3	Station 1	323 N. 4th	Fire Suppression	Small area,	3	13900	3066	22.06%
4	Station 3	1257 W. Pierce	Fire Suppression		4	8957	4200	46.89%
5	Station 4	1601 N. 3rd	Fire Suppression	Roof in poor	4	7822	3720	47.56%
6	Station 5	1840 E.	Fire Suppression	Roof in poor	4	6121	4221	68.96%
7	Station 6	368 W. Apache	Fire Suppression		2	5670	3900	68.78%
8	Station 7	403 E. Hatcher	Fire Suppression	Needs new	4 if new	5325	3371	63.31%
9	Station 8	1025 E. Polk	Fire Suppression		4	12150	5622	46.27%
10	Station 9	330 E. Fairmont	Fire Suppression		4	11400	6577	57.69%
11	Station 10	2731 N. 24th	Fire Suppression	Potential	4	7574	4500	59.41%

FIELD VISITS

- Conducted on all buildings rated either a 4 or 5
- Visual documentation of roof structure, condition, and any obstructions not apparent on aerial image
- Spreadsheet was updated and changed with any new information

FIELD VISITS

- Site visits were necessary to change the ratings of buildings
- Driver Training Center

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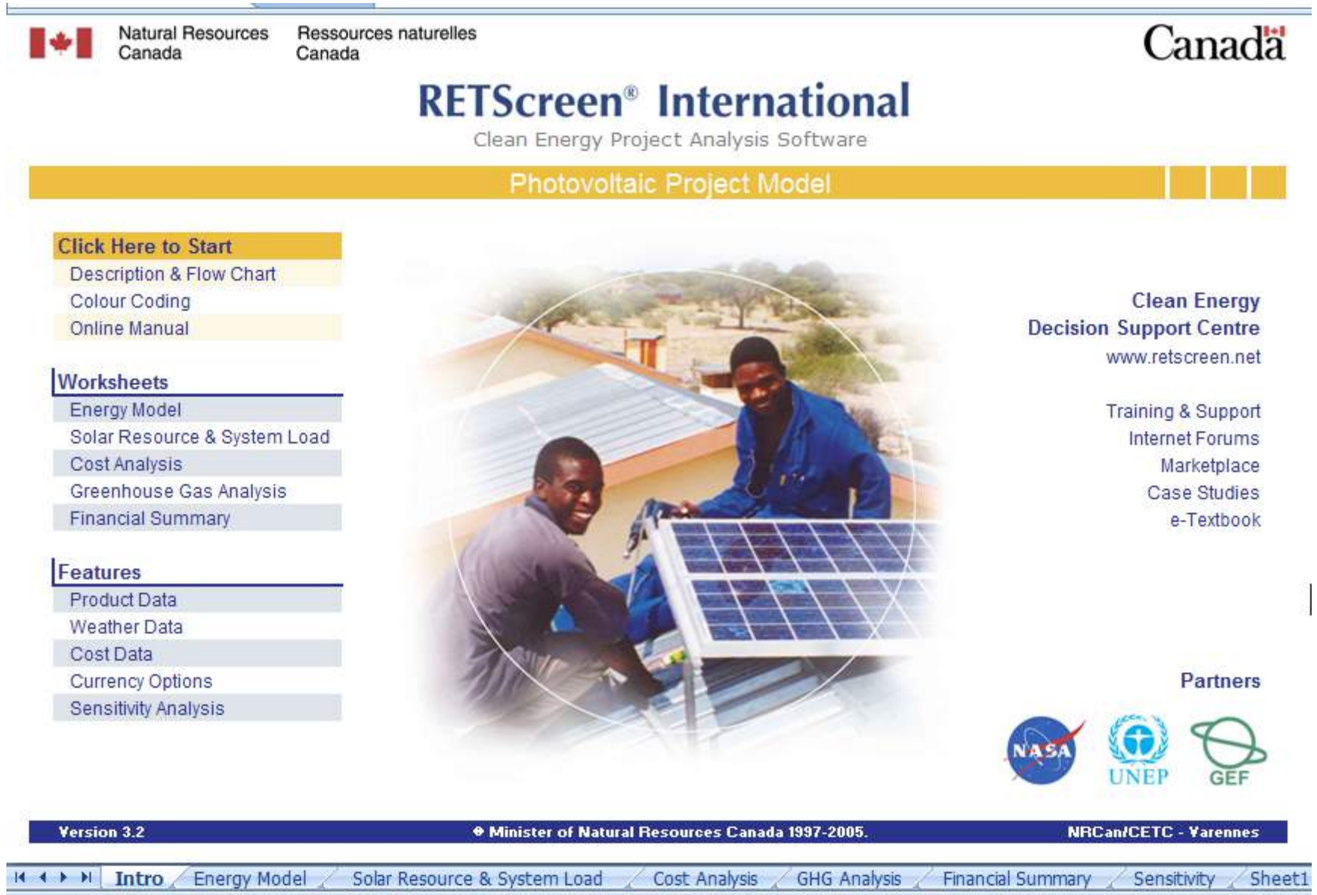
FIELD VISITS

- Aesthetic choices

RETSCREEN

- System performance was estimated using the RETScreen program



SYSTEM PERFORMANCE

- Analysis was performed only on buildings rated a 4 or 5
- Performance ranging from peak solar output from 6.66 W/ft2 to 11.84 W/ft2

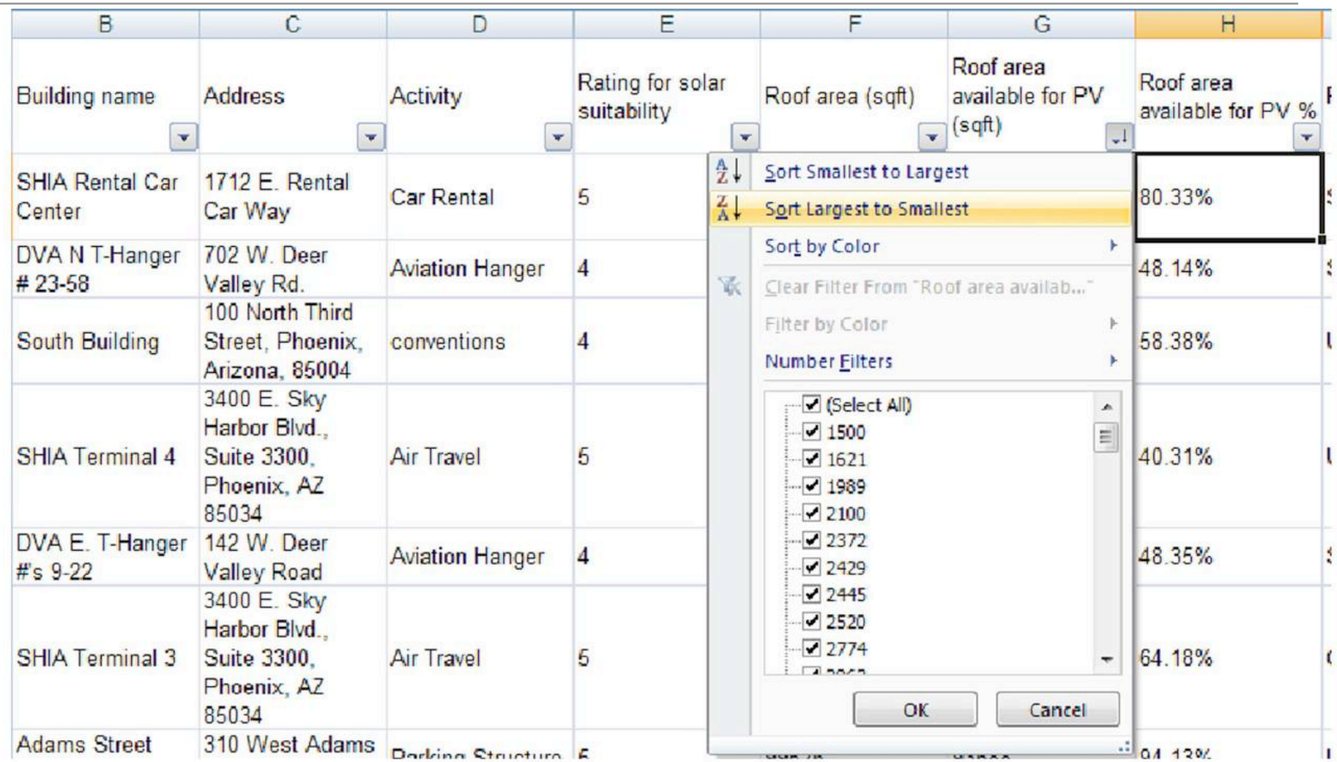
Thin film/amorphous	**Fixed 0˚ tilt**	Fixed 18˚ tilt	Single-Axis
PV array power (kWp/100sq.ft.)	**0.666**	0.592	
PV array area (sq.ft.)	**100**	100	
Annual kWh/100sq.ft.	**1158.3**	1120.8	
Peak kWp/sq.ft.	**0.00666**	0.00592	
kWh/sq.ft.	**11.583**	11.208	
Poly-crystalline	Fixed 0˚ tilt	Fixed 18˚ tilt	Single-Axis
PV array power (kWp/100sq.ft.)	1.008	0.896	0.896
PV array area (sq.ft.)	100	100	100
Annual kWh/100sq.ft.	1647.9	1591.2	2109.6
Peak kWp/sq.ft.	0.01008	0.00896	0.00896
kWh/sq.ft.	16.479	15.912	21.096
Mono-crystalline	Fixed 0˚ tilt	**Fixed 18˚ tilt**	Single-Axis
PV array power (kWp/100sq.ft.)	1.332	**1.184**	1.184
PV array area (sq.ft.)	100	**100**	100
Annual kWh/100sq.ft	2178	**2102.4**	2788
Peak kWp/sq.ft.	0.01332	**0.01184**	0.01184
kWh/sq.ft.	21.78	**21.024**	27.88

RESULTS

- Implementation, depending on system type, could result in power production of 15.58 MWp to 27.71 MWp
- If city owned parking structures were included, an additional 13 MWp - 23 MWp could be generated

THE DATABASE

- The master spreadsheet file is also able to be used as a search function
- As a tool for determining priority, the spreadsheet could be sorted according to solar rating, or roof area available for PV etc.



B	C	D	E	F	G	H
Building name	Address	Activity	Rating for solar suitability	Roof area (sqft)	Roof area available for PV (sqft)	Roof area available for PV %
SHIA Rental Car Center	1712 E. Rental Car Way	Car Rental	5			80.33%
DVA N T-Hanger # 23-58	702 W. Deer Valley Rd.	Aviation Hanger	4			48.14%
South Building	100 North Third Street, Phoenix, Arizona, 85004	conventions	4			58.38%
SHIA Terminal 4	3400 E. Sky Harbor Blvd., Suite 3300, Phoenix, AZ 85034	Air Travel	5			40.31%
DVA E. T-Hanger #'s 9-22	142 W. Deer Valley Road	Aviation Hanger	4			48.35%
SHIA Terminal 3	3400 E. Sky Harbor Blvd., Suite 3300, Phoenix, AZ 85034	Air Travel	5			64.18%
Adams Street	310 West Adams	Parking Structure	5			94.13%

CONCLUSIONS

- City operated buildings have a tremendous potential for solar power generation
- An ASU group did a similar project for the Tempe campus resulting in 16 MW of generation installed over several phases
- It is most likely that the city will use PPA's to finance their solar plans although there may be opportunities for federal grants to aid in the financing

REFERENCES

1 - Derived from Census data by TEGNOS Research, Inc. (2008)

2 - Assumes an average 5 watt peak solar power production per square foot of suitable roof surface (200 billion square feet X 25% usage factor X 5 W/sf)

THANK YOU

QUESTIONS?