

DavisFREE
100% Renewable: Technical Feasibility Study
August 14, 2015

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DNV GL

Background

Davis Future Renewable Energy & Efficiency (FREE)

- Support implementation planning for Davis “Climate Action and Adaptation Plan”

	Minimum	Desired
2020	1990 levels	28% below 1990 levels
2050	80% below 1990 levels	Carbon neutral

- Create roadmap for renewable energy and energy efficiency

DavisFREE Goal

Research:

Local solar (rooftop PV)

Large scale renewable energy

Research:

Net zero residential retrofit program

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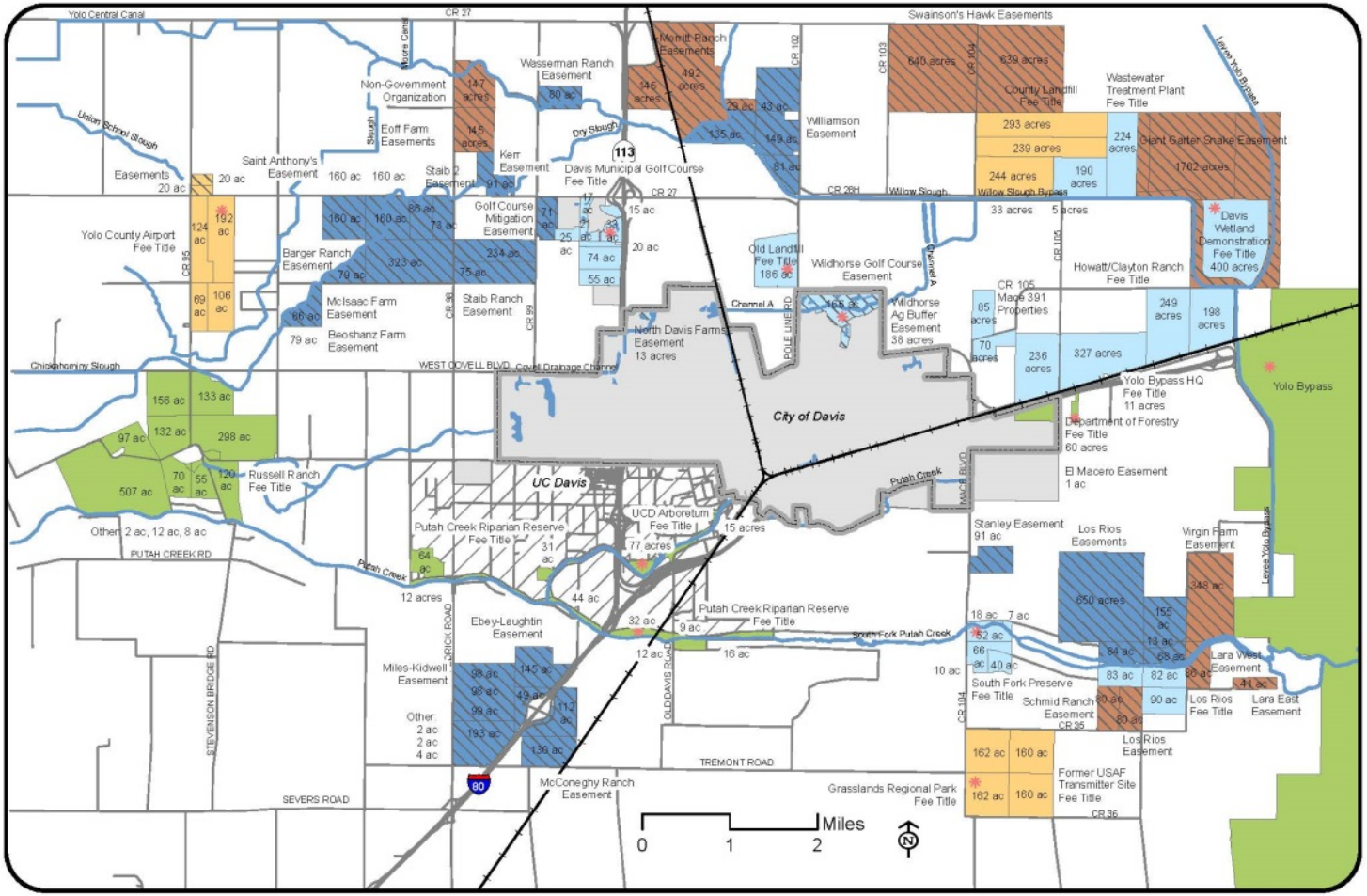
Resource Area

Confined to the Davis Planning area



Public Lands and Easements as of January 2014

Within the City of Davis Planning Area

- City of Davis
- City of Davis + NGO
- NGO
- County of Yolo
- State of California
- Easements
- Public Access

DNV·GL

Assessment of Renewable Resource Opportunities

Focus on utility-scale renewable resource potential

- Solar photovoltaic (PV) - ground-mounted and carport
- Concentrating solar power (CSP)
- Geothermal
- Small-hydroelectric
- Wind
- Biomass

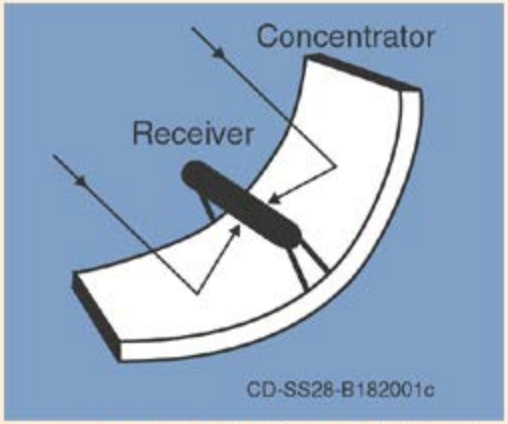


Figure 1: Parabolic Trough System Schematic Diagram

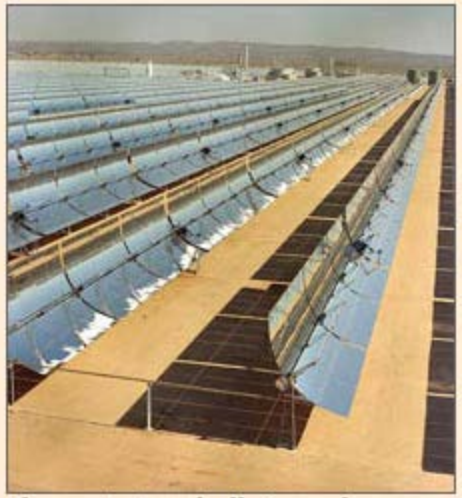


Figure 2: Parabolic trough system.

Assessment of Renewable Energy Technology Costs

- Generic pre-defined input includes
  - Installed costs
  - Variable costs, eg. O&M and fuel
  - Financing costs, ie terms and rates
  - Incentives availability, eg. tax credits and accelerated depreciation
  - Generation: Capacity factor and degradation factor
- Unique input includes
  - A cost curve to capture projected cost decline from 2014-2020 by technology to capture installed costs decrease
  - Interconnection costs in the Davis area
  - Transmission costs
  - Available land area

Cost of Energy Methods

- Levelized Cost of Energy model was developed to compare cost of energy (i.e. lifetime generation/ lifetime cost)
  - By resource type
  - By location
- User input includes
  - Planned installed year
  - Financing mechanism

2015	2016	2017	2018	2019	2020
20%	10%	40%	30%	0%	0%

Cash	Muni	3rd party
0%	0%	100%

Cost of Energy Results

Weighted average cost of energy across 2015-2020

		Distribution				Transmission		
Levelized cost of generation		City (preferred)	City	PG&E (preferred)	PG&E	CAISO	BANC	Other
Solar PV	Fixed - 1 MW	$ 129.20	$131.67	$ 129.20	$131.67	$ 131.67	$ 129.38	$ 129.15
Solar PV	Fixed - 5 MW	$ 120.75	$123.23	$ 120.75	$123.23	$ 123.23	$ 120.93	$ 120.70
Solar PV	Fixed - 10 MW	$ 111.26	$113.74	$ 111.26	$113.74	$ 113.74	$ 111.45	$ 111.22
Solar PV	Fixed - 20 MW+	$ 106.94	$109.42	$ 106.94	$109.42	$ 109.42	$ 107.12	$ 106.89
Solar PV	Tracking - 1 MW	$ 119.84	$121.99	$ 119.84	$121.99	$ 121.99	$ 119.69	$ 119.46
Solar PV	Tracking - 5 MW	$ 112.00	$114.15	$ 112.00	$114.15	$ 114.15	$ 111.85	$ 111.62
Solar PV	Tracking - 10 MW	$ 104.28	$106.42	$ 104.28	$106.42	$ 106.42	$ 104.13	$ 103.90
Solar PV	Tracking - 20 MW+	$ 100.75	$102.90	$ 100.75	$102.90	$ 102.90	$ 100.60	$ 100.37
Solar PV	Distributed	$ 153.04	$156.14	$ 153.04	$156.14	$ 156.14	$ 153.85	$ 153.62
Solar Therma	Solar Thermal	$ 204.49	$204.49	$ 204.49	$204.49	$ 204.49	$ 202.19	$ 201.96
Wind	Class 1	$ 155.21	$156.16	$ 155.21	$156.16	$ 156.16	$ 153.86	$ 153.63
Wind	Class 2	$ 103.75	$108.63	$ 103.75	$108.63	$ 108.63	$ 106.34	$ 106.11
Wind	Class 3	$ 92.34	$108.91	$ 92.34	$108.91	$ 108.91	$ 106.61	$ 106.38
Wind	Distributed Class 1	$ 70.17	$ 72.09	$ 70.17	$ 72.09	$ 72.09	$ 69.79	$ 69.56
Wind	Distributed Class 2	$ 101.47	$103.98	$ 101.47	$103.98	$ 103.98	$ 101.68	$ 101.45
Wind	Distributed Class 3	$ 117.26	$119.95	$ 117.26	$119.95	$ 119.95	$ 117.66	$ 117.43
Biomass	Distributed	$ 389.65	$390.78	$ 389.65	$390.78	$ 390.78	$ 388.49	$ 388.26
Biomass	Large	$ 267.60	$268.86	$ 267.60	$268.86	$ 268.86	$ 266.56	$ 266.33
Biogas	Biogas	$ 654.56	$656.14	$ 654.56	$656.14	$ 656.14	$ 653.84	$ 653.61
Geothermal	Geothermal	$ 53.60	$ 53.92	$ 53.60	$ 53.92	$ 53.92	$ 51.62	$ 51.39

Elimination of Renewable Resource Opportunities

- Concentrating solar power
  - Too expensive at this time, and requires more land than is available in the Davis Planning Area.
- Geothermal
  - Although California has excellent geothermal resources, they are well outside the Davis Planning area.
  - The closest viable resource is the “Geysers” area near Calistoga
- Small-hydroelectric
  - Not viable in the area

Elimination of Renewable Resource Opportunities

- Wind
  - Utilized UC Davis meteorological tower data to determine that very few locations viable
- Biomass
  - Evaluated biomass residues for all of Yolo County
  - Consulted with the California Biomass Collaborative
  - The residues are not much to work with and most already have other intended uses.

Renewable Resource Production Potential

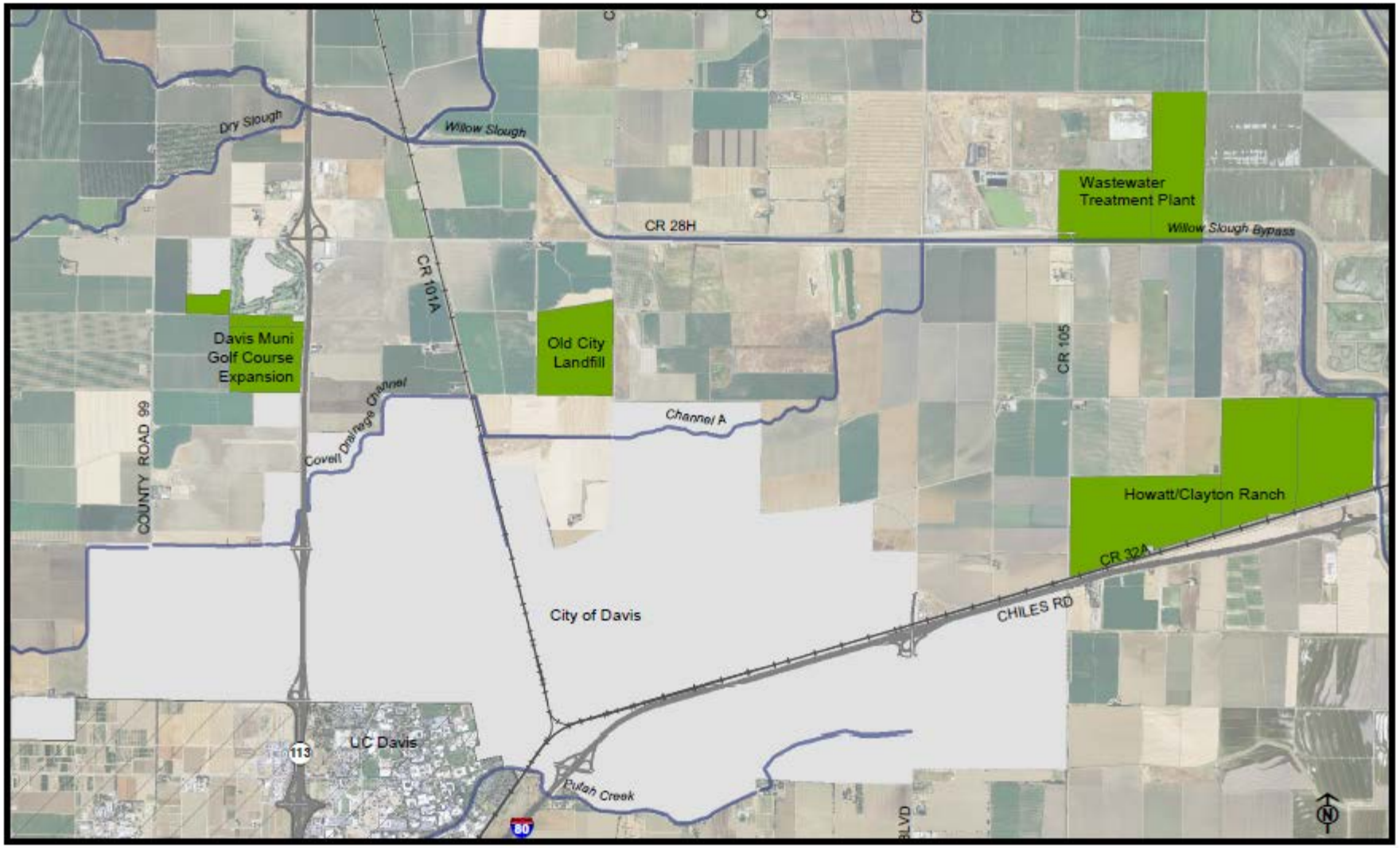
- Solar PV resulted as the only viable renewable large-scale resource in the Davis Planning Area
- Worked with City to identify likely available locations for PV installation
- Technology comparison for solar PV
- Costs and land-use requirements for enough PV to meet City needs

Resource Production Potential - Results

Solar PV by racking type snap-shot

Fixed Tilt		Single-Axis		Dual-Axis	
MWdc Installed	GWh/Year	MWdc Installed	GWh/Year	MWdc Installed	GWh/Year
178.83	299.88	154.41	308.86	103.34	229.64

City Owned Land with Community Solar Potential



Electricity Generation Potential

Property	Acres	MW
Davis Municipal Golf Course	149	20
Old City Landfill/PVUSA Site	186	25
Wastewater Treatment Plant	224	30
Howatt/Clayton Ranch	773	103
Wastewater Treatment Plant	2	0
Playfields Park	1	0
Mace Park and Ride	1	0
Pubic Works Corp Yard	4	1
Parks Corp Yard	2	0
Totals		179

Conclusions

Most of Davis' energy usage can realistically and economically be supplied by solar, resulting in a near zero local carbon footprint within 2 decades

Thank you!

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SAFER, SMARTER, GREENER

APPENDICES

Concentrating Solar Power - Dish Engine Systems

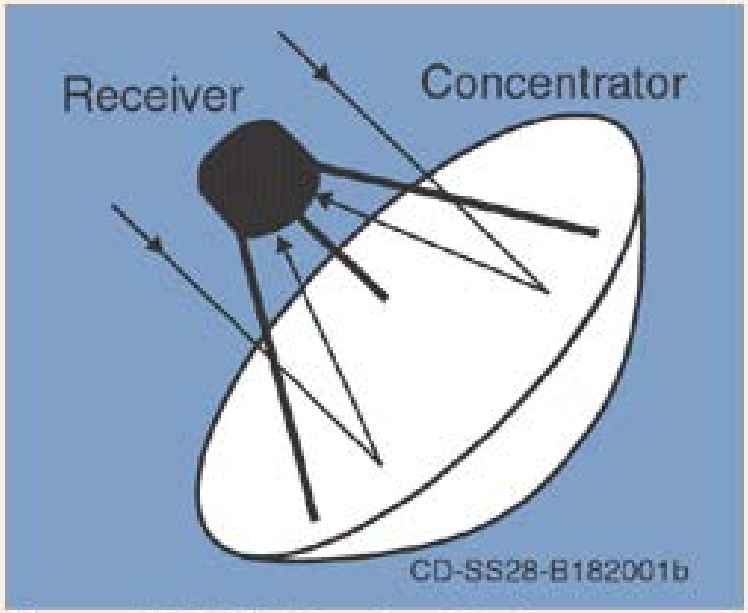
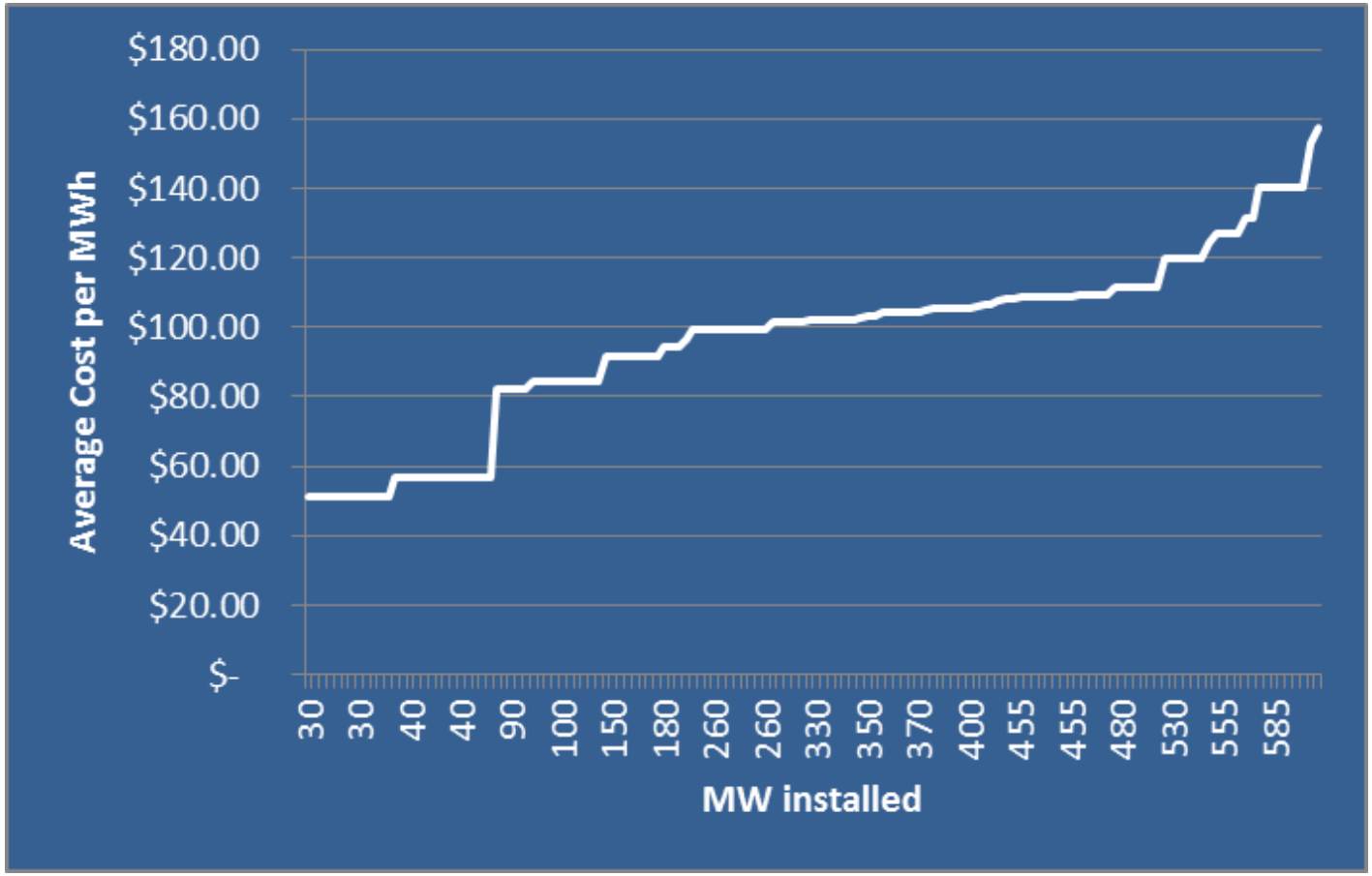


Figure 5: Dish/engine System Schematic Diagram

Figure 6: Solar dish-engine system.

Supply Curve

Least Cost = $ 58.72 /MWh, assuming the City needs 100 MW of new generation



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