Integrated Resource Planning Stakeholder Engagement Workshop

Workshop #4

January 31, 2019

Welcome Remarks

Executive Summary

- The Michigan Public Service Commission (MPSC) Integrated Resource Planning (IRP) filing requirements have outlined recommendations for performing public outreach prior to filing an IRP. As part of the MPSC IRP filing requirement in Public Act 341, participant engagement in the development of the IRP is strongly encouraged
- In the 12 months prior to an IRP filing, electric utilities are encouraged to host workshops with interested participants for input and to stay informed regarding:
  - The assumptions, scenarios, and sensitivities
  - The progress of the utility's IRP process
- This is the fourth and final Technical workshop for IRP stakeholders prior to the filing
  - Previous Technical workshops were held throughout 2018, specifically June 11th, September 27th, and November 12th
  - There have also been three open houses to educate the public on the Company's planning process as well as provide an opportunity for public comments
  - **Today we will present the results of our IRP modeling. Note these results are considered "preliminary" as we are still performing quality checks on all the outputs**
- DTE will be filing an IRP on March 29, 2019

Workshop agenda

- The workshop will be broken into four parts:
  1. Welcome & administration
  2. Presentation
  3. Questions
  4. Comments

- Introductions
  – Facilitators
  – Presenters
  – Roll call (WebEx Participants)
    - *After roll call participants will be put on listen only mode for the duration of the conference*

Safety

- Evacuations – Beacon Park / Navitas
- Call 313-235-9113 – Volunteer?
- CPR / First Aid - Volunteer?

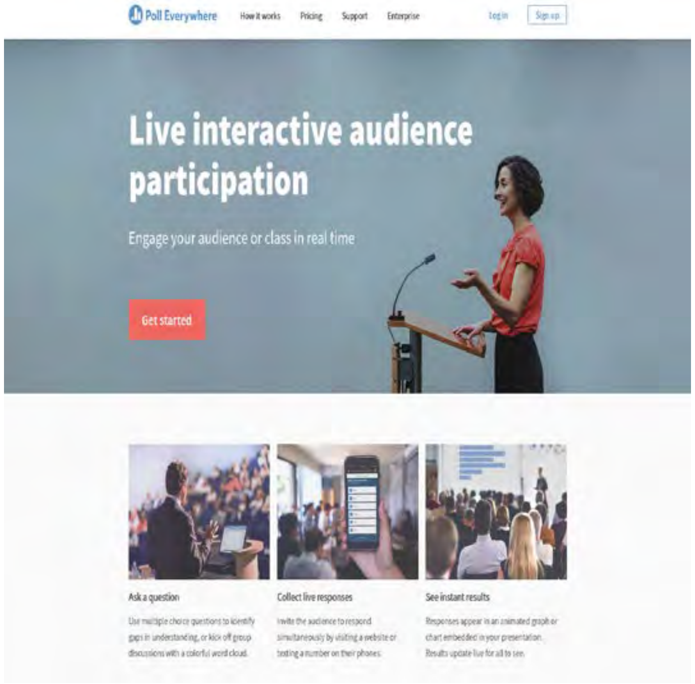
Note: If you need to leave early, please notify one of the DTE Personnel so you can be checked out at the security

The same process as the last two technical conferences will be used for questions and comments

- Text **DTECOMMENTS to 37607** for questions or comments as they arise during the presentation. (**Please limit questions and comments to 1 per text)**
- If using laptop or tablet respond using **pollev.com/dtecomments** (**Please limit questions and comments to 1 at a time)**

WebEx participants please submit all questions through Poll Everywhere to ensure the question is added to the queue

- For your first text please give your name and affiliation
- We will not be monitoring the WebEx chat box for questions
- A DTE subject matter expert (SME) may answer the questions as we work through the topics, or we will address them at the end
- At the end of the formal presentation, we will take a break where additional questions can be asked, in addition, we will leave polling open for 30 minutes after the meeting has concluded
- The moderator will read the questions and a DTE SME will provide a response; comments will also be read
- This process allows us to document the questions asked, and maintain the flow of the formal presentation



Presentation agenda

- **Energy Waste Reduction Overview**
- Market Valuation Results
- Strategist Optimization Results
- Risk Assessment Methodologies
- Assessing Planned Levels of Renewable Penetration
- Next Steps

Overview of energy waste reduction (EWR) modeling improvements in the 2019 Integrated Resource Plan (IRP)

DTE Energy

Presented on 1-31-19. Any analysis shown is preliminary and subject to change

DTE applied a more detailed approach towards its modeling of EWR inputs in the 2019 IRP. A few of the key enhancements implemented are listed below and discussed in detail on the following slides:

1. Modeled various levels of EWR savings using the DTE 2018 Potential Study
2. Calculated EWR savings by end-use for a more comprehensive analysis
3. Applied end-use load shapes for more accurate hourly savings projections
4. Modeled measure life by end-use for more accurate lifetime savings
5. Used varying incentive levels for more accurate cost assumptions

Various levels of EWR were modeled in the IRP. The DTE 2018 Potential Study was used to determine EWR savings limits

DTE Energy

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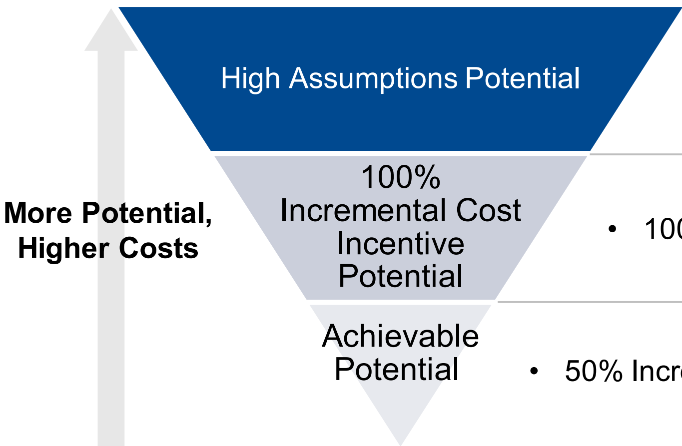
Potential study scenarios used to determine energy saving limits*



- 100% Incremental Incentive Costs
- Higher Avoided Energy & Capacity Costs
- Optimistic Market Penetration

- 100% Incremental Incentive Costs

- 50% Incremental Incentive Costs

Levels of EWR included in the IRP

EWR Level	Potential Scenario Used
1.50%	Achievable Potential
1.75%	Achievable Potential
2.00%	Achievable Potential
2.25%	100% Incremental Cost Incentive Potential
2.50%	High Assumptions Potential

If there was not enough potential in the Achievable Potential to deliver the desired level of EWR, the next more aggressive potential scenario that could deliver the targeted EWR savings level was used

***Source:** 2018 Electric Energy Efficiency Potential Study prepared by GDS Associates, Inc.

DTE modeled EWR savings by end-use for a more comprehensive assessment

DTE Energy

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- DTE developed EWR savings estimates by Residential and Commercial & Industrial (C&I) end-uses in the 2019 IRP modeling effort. End-use is a category of equipment or service that consumes energy.
- In comparison, DTE modeled EWR savings using three tranches (i.e. high, medium, and low savings potential) in the 2017 IRP.
- The end-uses used in the 2018 DTE Potential Study include the segments listed in the following table:

C&I End-Uses	Residential End-Uses
1. Lighting	1. Lighting
2. HVAC	2. Electronics
3. Office Equipment	3. Appliances
4. Refrigeration	4. HVAC Equipment
5. Machine Drive	5. HVAC Shell
6. Compressed Air	6. Water Heating
7. Ventilation	7. Behavior
8. Water Heating	8. Miscellaneous
9. Cooking	
10. Agriculture	
11. Process Cooling/Heating	
12. Pools	
13. Miscellaneous	

DTE worked with Navigant Consulting to develop end-use load shapes for use in EWR modeling efforts

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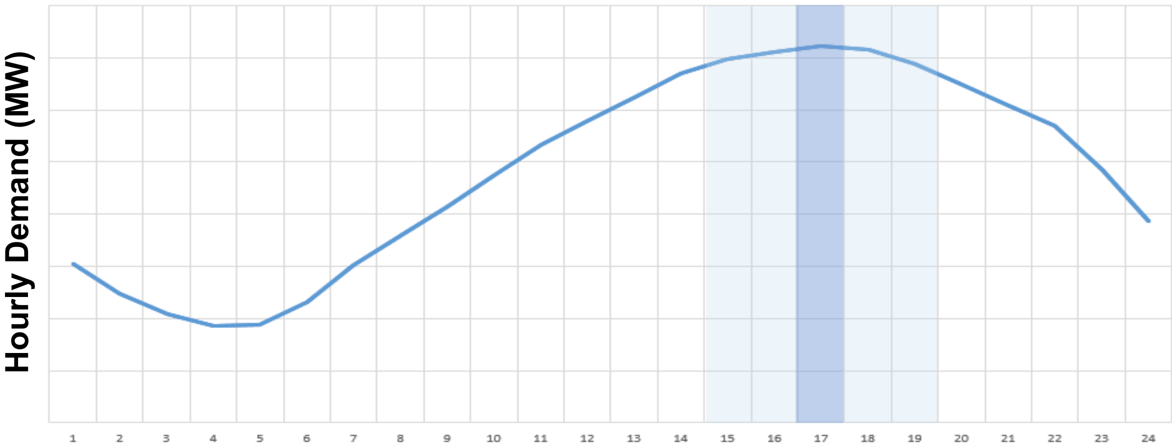
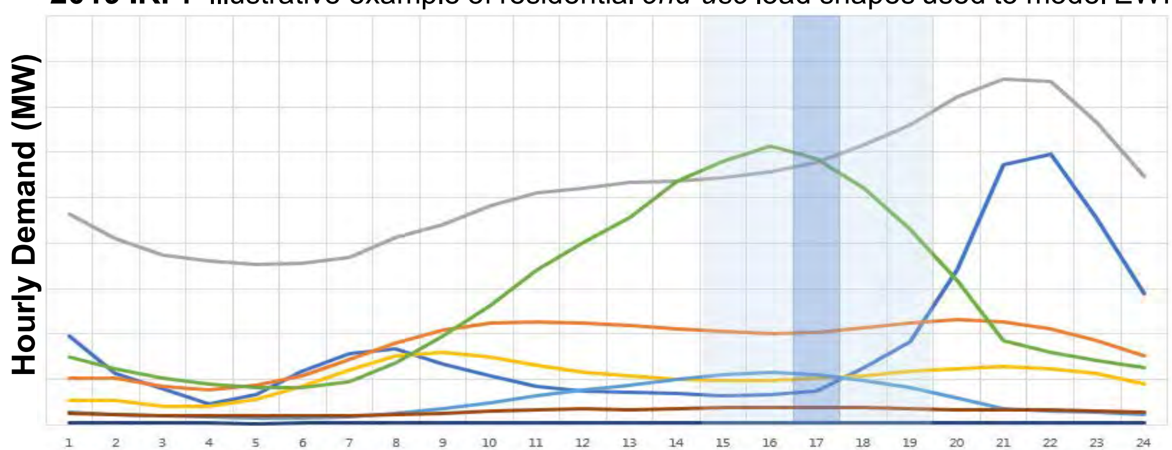
2017 IRP: Illustrative example of residential *generic* load shape used to model EWR



In DTE's 2017 IRP, annual EWR savings were distributed into hourly savings using a general load shape. Therefore, every end-use included the same EWR savings profile

2019 IRP: Illustrative example of residential *end-use* load shapes used to model EWR



In DTE's 2019 IRP, annual EWR savings were distributed into hourly savings using specific end-use load shapes. Therefore, every end-use includes a distinct EWR savings profile

DTE used the weighted average measure life for each end-use, by year, to calculate lifetime savings

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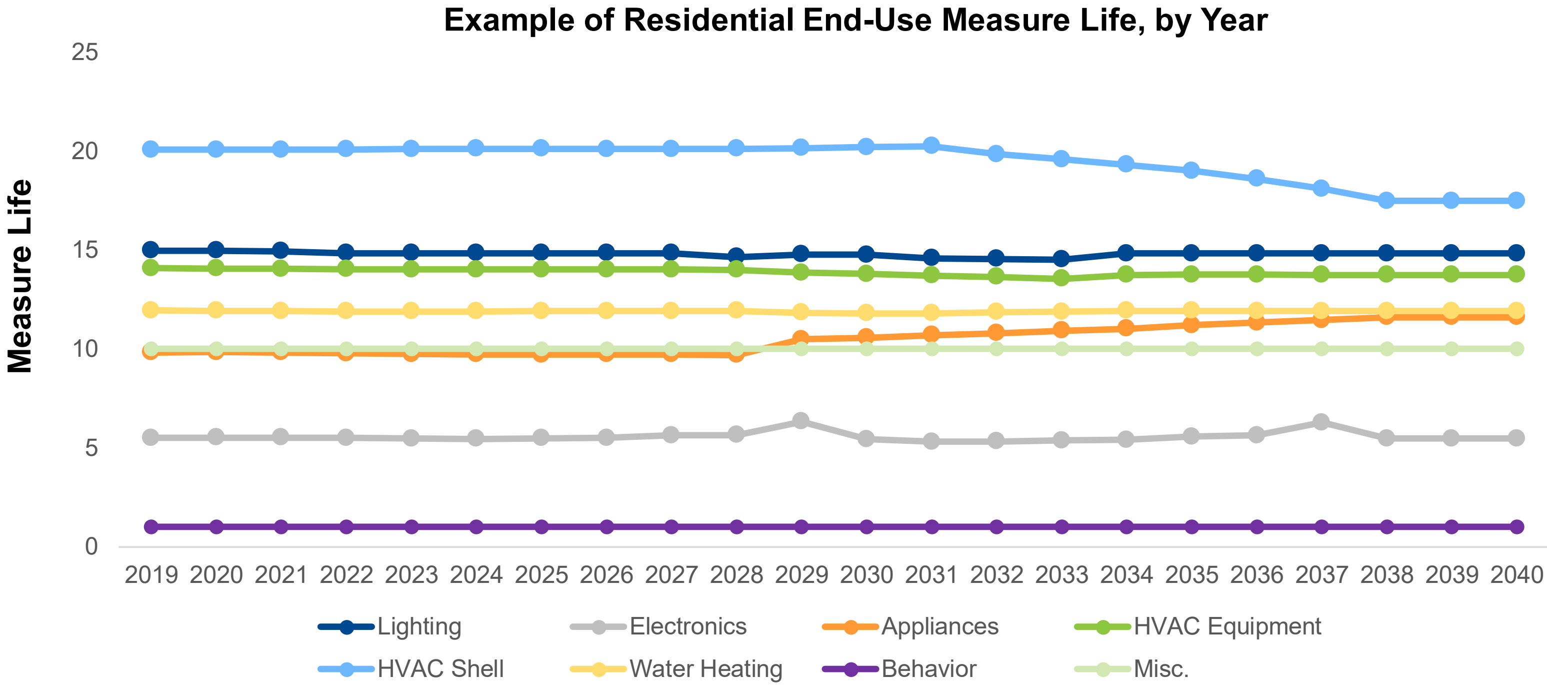
DTE worked with GDS to calculate the weighted average measure life, by year, for all 21 end-uses identified in the 2018 DTE Potential Study (8 Residential and 13 C&I). This approach resulted in **462** data points used to capture the effects of a changing measure mix over the IRP planning period and more accurately account for the cumulative impact of EWR savings. In comparison, DTE used a 15 year measure for all EWR savings in the 2017 IRP.



DTE applied a more detailed approach towards EWR spend by varying end-use incentive levels required to deliver increasing levels of potential savings

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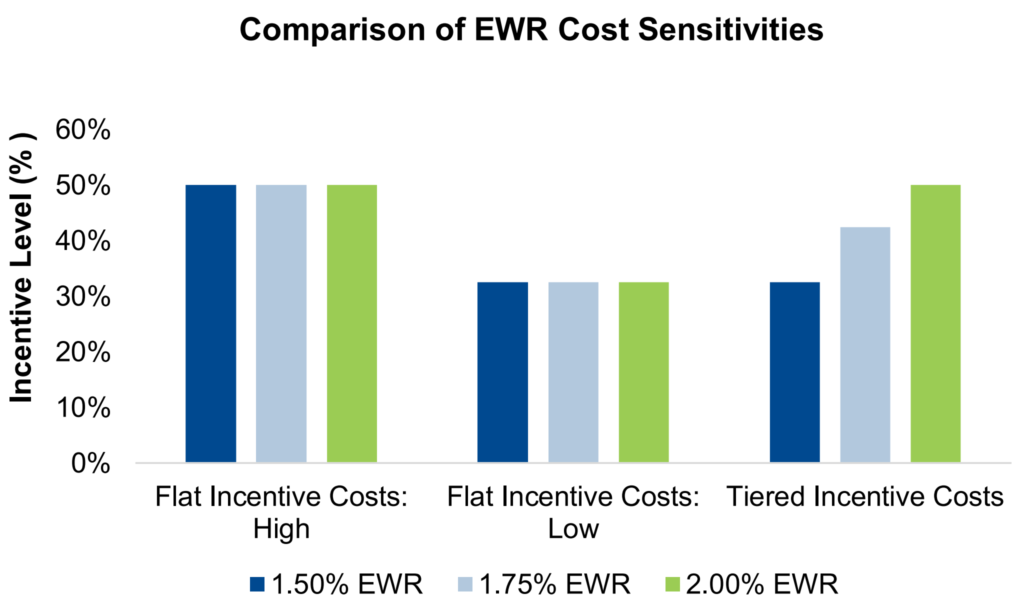
For each EWR savings level, the Company applied several incentive cost sensitivities, including:

- **Flat Incentive Costs: High**
  Based on the incentive level of 50% of incremental measure costs used for Achievable Potential in the DTE 2018 Potential Study

- **Flat Incentive Costs: Low**
  Assumes technology costs for EWR measures are reduced 35% from the level determined by the Potential Study Costs (aligns with Emerging Technology scenario in IRP Modeling Guidelines)

- **Tiered Incentive Costs**
  Recognizes that incentive costs have historically increased as the EWR savings level increase. Uses the Company's actual incentive costs to deliver the 1.50% level and incrementally increases to align with the potential study incentive costs assumptions to deliver 2%



Non-incentive costs were based the Company's historical non-incentive cost per kWh. Residential non-incentive costs were assumed to be $0.08402 per first-year kWh. Commercial & industrial non-incentive costs were assumed to be $0.03538 per first-year kWh. Non-incentive costs were escalated by the rate of inflation

Presentation agenda

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To narrow down the modeled resource options, we incorporated a Market Valuation using Benefit-Cost Analysis into our screening process

DTE Energy

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Market Valuation Analysis

Benefit	Cost
Capacity	Capital Investment
Energy	O & M
CO_2 Reduction	Fuel
Tax Incentive	Emissions

- A detailed and comprehensive analysis of operational and economic impacts from each specific resource option
- The Benefit-Cost Analysis is a tool used to eliminate options that do not make economic sense at a high level
- From the analysis, a benefit cost ratio is computed. The ratio takes into account the financial benefits realized by investing in a technology and compares it to the costs of executing the project. (The ratio is calculated by dividing the present value benefits by the present value costs)
- The higher the benefit cost ratio, the better the investment
- Computing the ratio allows for the alternative resources to be ranked
- Higher ranked resources will be modeled at a detailed level in the next analysis steps

Market Valuation analysis provides an indication of resource economic ranking and provides insight into the results of an optimization

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Rank	Resource (MW)	Benefit / Cost[1]
1	DR - Real Time Pricing - (3)	2.88
2	DR - Variable Peak Pricing - (92)	2.65
3	Conservative Volt Reduction - (64)	2.65
4	DR - Time of Use - (167)	1.71
5	DR - Demand Buyback - (49)	1.36
6	Advanced CCGT (1x1) - (414)	1.12
7	EWR 1.75	0.99
8	Wind with PTC - (150)	0.96
9	Solar with ITC - (50)	0.93
10	Advanced CT - (237)	0.89
11	EWR 2.0	0.88

Rank	Resource (MW)	Benefit / Cost[1]
12	RICE (CT) - (85)	0.87
13	CCGT-CCS - (340)	0.76
14	DR - Voltage Optimization - (51)	0.61
15	EWR 2.25	0.49
16	DR - DLC Smart Thermostats - (29)	0.39
17	DR – Capacity Bidding - (92)	0.35
18	DR – Behavioral - (12)	0.35
19	DR - AC - (26)	0.31
20	LITH-ION Battery - (100)	0.30
21	DR - DLC Water Heating - (76)	0.28
22	EWR 2.5	0.17

Example:	Real Time Pricing	Time of Use
Capacity, MW	3	167
TOTAL COST, $M	$0.18	$17.2
TOTAL BENEFIT, $M	$0.53	$29.4
Market Value[2], $M	$0.35	$12.2
Benefit Cost Ratio	2.88	1.71

1. For this analysis, the higher the number, the better the alternatives. Results from DTE Reference Case.
2. Market Value = Benefit minus Cost; The value of building the asset instead of buying from the market

Scenarios have different market assumptions which impact the resource alternatives likely to be selected in the market valuation analysis

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MPSC Required: BAU, ET, EP

Scenarios	Key Market Assumptions
Business as Usual (BAU)	• EIA gas forecast • No CO_2 price
Emerging Technology (ET)	• EIA gas forecast • 35% capital reduction for DR, EWR, CHP, storage, and solar • 17.5% capital reduction for wind
Environmental Policy (EP)	• EIA gas forecast • 35% capital reduction, solar and wind • 30% CO_2 reduction by 2030
DTE Reference (DTE)	• DTE gas forecast • Nominal CO_2 price starting in 2025 ($5/ton)

The resource alternatives remain consistent; however, the order changes dependent on scenario market assumptions and cost inputs

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BAU Scenario

Rank	Resource
1	DR - Real Time Pricing
2	DR - Variable Peak Pricing
3	EWR 1.75%
4	EWR 2.0%
5	DR - Time Of Use
6	ADV CCGT (1X1)
7	Wind with PTC
8	Solar with ITC
9	DR - Demand Buyback
10	Advanced CT
11	EWR 2.25%
12	LITH-ION Battery

EP Scenario

Rank	Resource
1	EWR 1.75%
2	EWR 2.0%
3	Wind with PTC
4	Solar with ITC
5	DR - Real Time Pricing
6	ADV CCGT (1X1)
7	DR - Variable Peak Pricing
8	Advanced CT
9	DR - Time Of Use
10	DR - Demand Buyback
11	EWR 2.25%
12	LITH-ION Battery

35% Capex for Renewables

ET Scenario

Rank	Resource
1	EWR 1.75%
2	EWR 2.0%
3	DR - Real Time Pricing
4	Solar with ITC
5	DR - Variable Peak Pricing
6	Wind with PTC
7	ADV CCGT (1X1)
8	Advance CT
9	DR - Time Of Use
10	DR - Demand Buyback
11	EWR 2.25%
12	LITH-ION Battery

35% Capex for Solar
17.5% Capex for Wind

Matrix of Scenario and Sensitivities Run

DTE Energy

Presented on 1-31-19. Any analysis shown is preliminary and subject to change

Sensitivity Description	FLAT HIGH EWR COST / TIERED EWR COST			FLAT LOW EWR COST
STARTING POINT	DTE REF	BAU	EP	ET
1.5 / 1.75 / 2.0 / 2.25 / 2.5	X / X	X / X	X / X	X
High GAS SENSITIVITY				
1.5 / 1.75 / 2.0 / 2.25 / 2.5		X / X	X / X	X
High CO2 SENSITIVITY				
1.5 / 1.75 / 2.0 / 2.25 / 2.5	X / X			
High LOAD SENSITIVITY				
1.5 / 1.75 / 2.0 / 2.25 / 2.5		X/	X/	X
High EV SENSITIVITY				
1.5 / 1.75 / 2.0 / 2.25 / 2.5	X / X			
25% CHOICE CAP				
1.5 / 1.75 / 2.0 / 2.25 / 2.5		X/		
50% CHOICE RETURNS				
1.5 / 1.75 / 2.0 / 2.25 / 2.5		X/		
100% CHOICE RETURNS				
1.5 / 1.75 / 2.0 / 2.25 / 2.5		X/		
50% CO2 REDUCTION				
1.5 / 1.75 / 2.0 / 2.25 / 2.5			X/	
STAKEHOLDER SENSITIVITY N	X / X			
DR SENSITIVITY	X / X			
+300 DISTRIBUTED RENEWABLES	X / X			
BLRPP RETIREMENT ANALYSIS	X / X			
CT ONLY - 1.5%		X/		

X – Run Complete **X** – Run in Progress

Presentation agenda

- Energy Waste Reduction Overview
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The starting point for renewable energy is consistent with the filed renewable energy plan, 50% Clean Energy by 2030, and 80% CO_2 reduction by 2050

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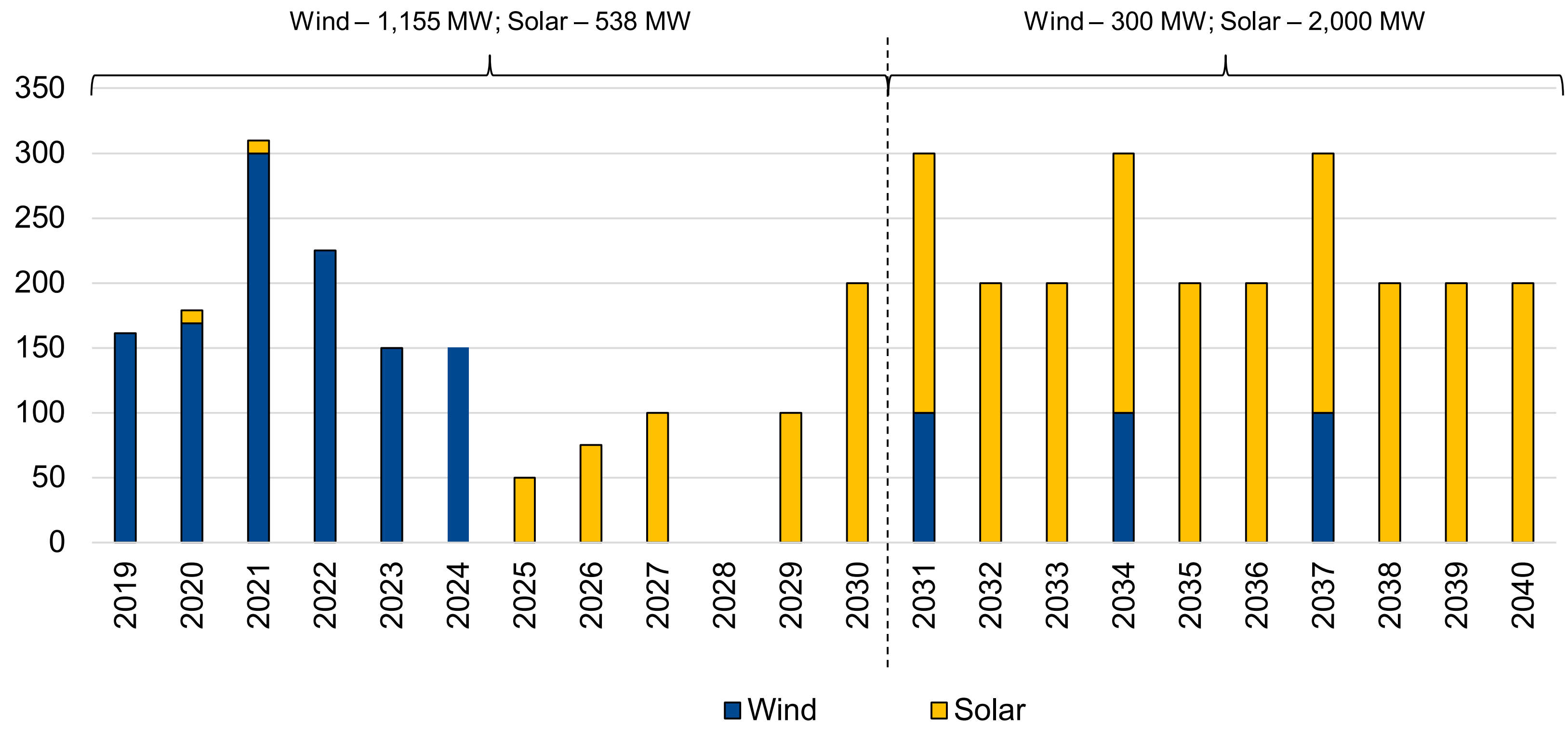
Assumed Renewable Energy Build Plan[1] (MW)



1. Assumes all purchased power agreements and PURPA contracts are extended

The starting point for demand response, in all cases, is consistent with the forecast included in the 2017 capacity demonstration filing

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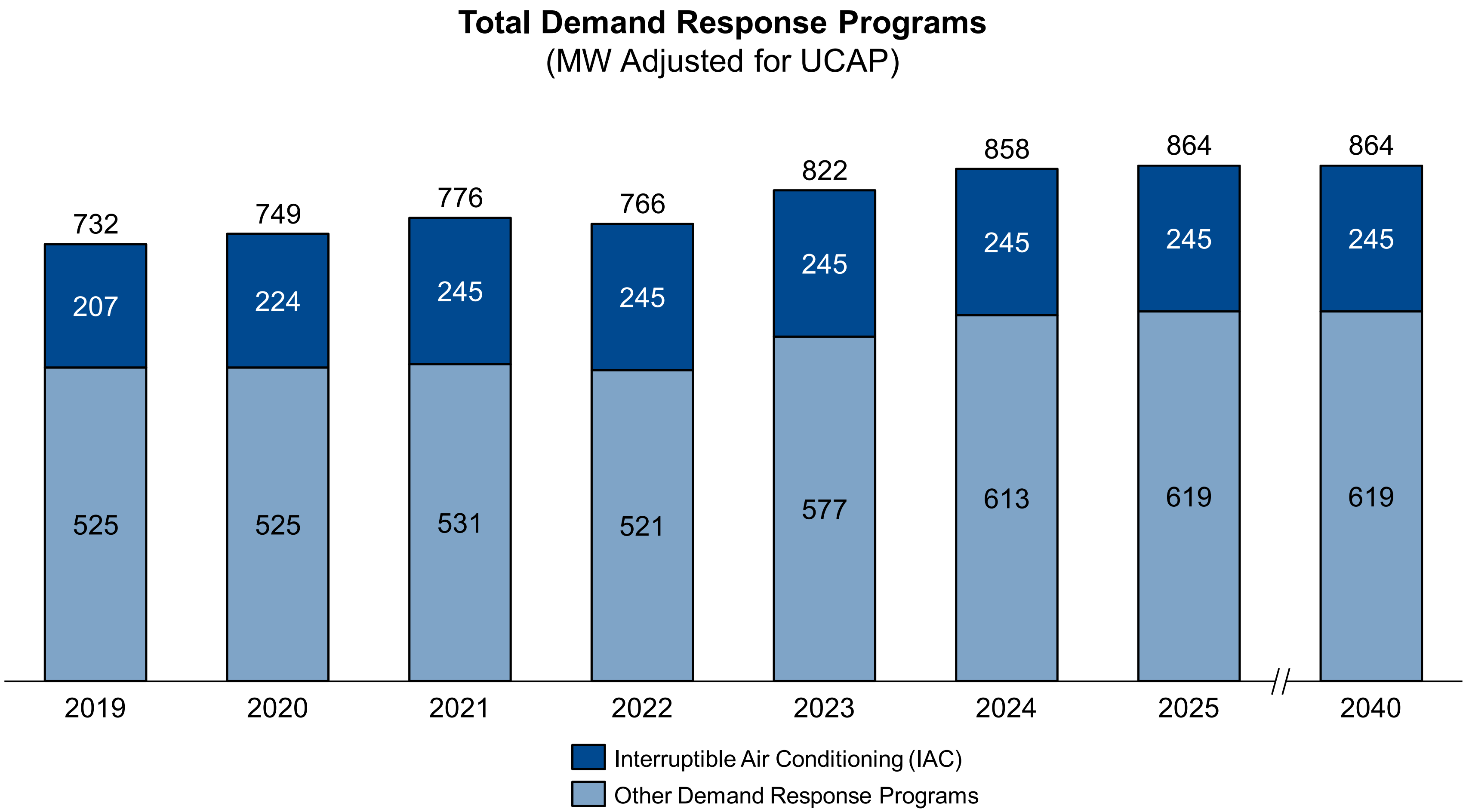

1. DR levels consistent with 2017 capacity demonstration. We plan to refresh the DR levels prior to the March 2019 filing which will be consistent with the December 2018 capacity demonstration

Due to renewables and DR increases in the 2020's, DTE does not expect to have a capacity need until 2029 which grows from ~150MW to ~600MW in 2030

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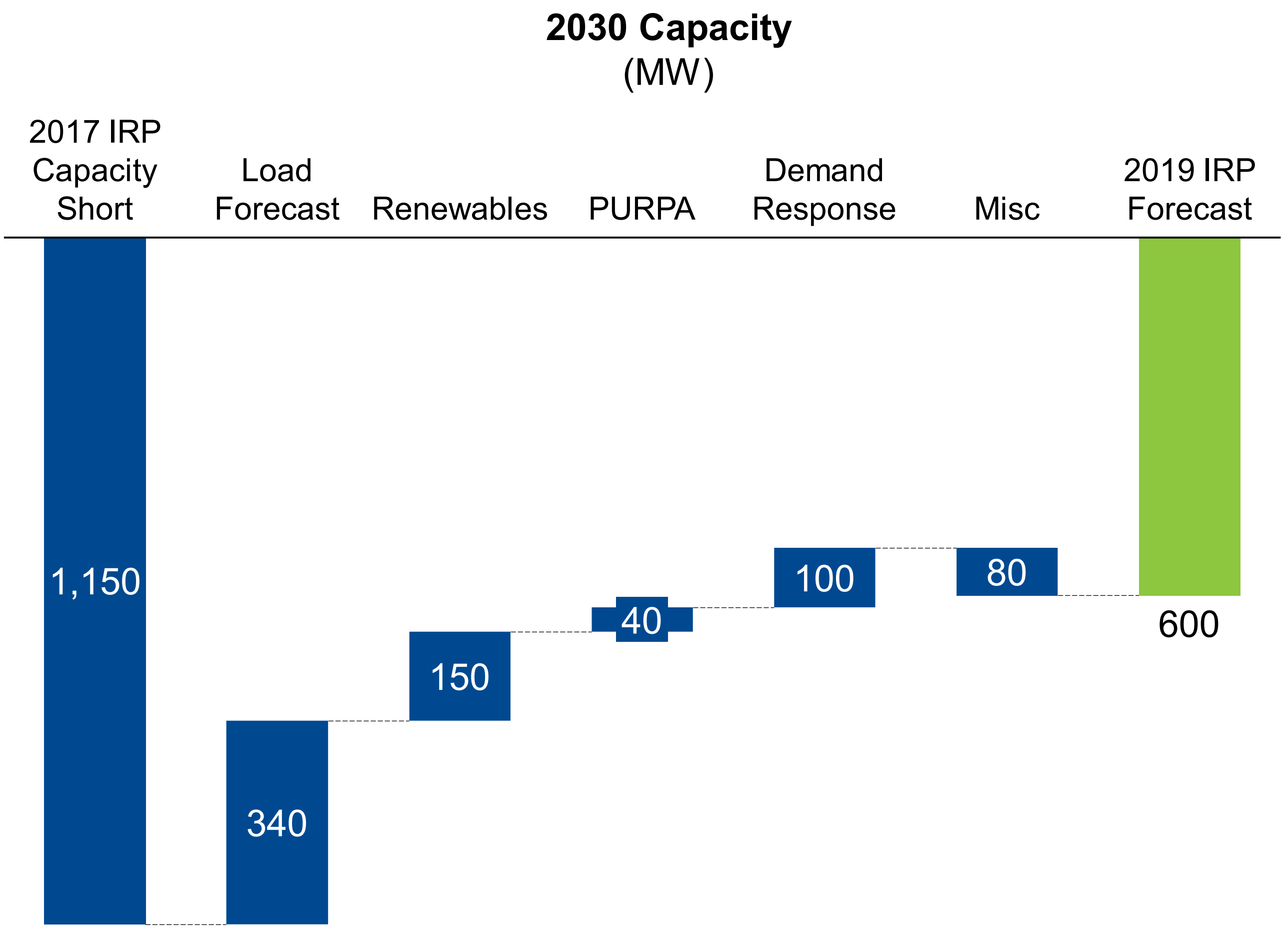

Alternatives evaluated to fill capacity short

Wind
Solar
Combustion Turbine
Combined Cycle
Energy Efficiency
Demand Response
Energy Storage

Nine least-cost build plans were selected from Strategist optimization modeling runs and were evaluated across four scenarios

DTE Energy

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1 Run an optimization in Strategist, select least cost build plan for each scenario and EWR combination

2 Compile Least Cost Build Plans from Strategist Model

DTE Reference

EWR	1.5%	1.75%	2.00%
CCGT	414	414	414
DR	259	-	-
Wind	-	-	-

Business as Usual

EWR	1.5%	1.75%	2.00%
CCGT	414	414	414
DR	167	-	-
Wind	150	-	-

Emerging Technology

EWR	1.5%	1.75%	2.00%
CCGT	414	-	-
DR	-	167	-
Wind	1,500	1,800	1,050

Environmental Policy

EWR	1.5%	1.75%	2.00%
CCGT	-	-	-
DR	216	-	-
Wind	3,300	3,150	1,050

Comparison Plan: DTE Reference 1.5%

Identical Build: DTE Reference 1.75% and Business as Usual 1.75%

Identical Build: DTE Reference 2.00% and Business as Usual 2.00%

Identical Build: Emerging Technology 2.00% and Environmental Policy 2.00%

3 Calculate the net present value revenue requirement for each of the 9 plans and evaluate against a comparison plan. In the next four slides, we will show how the economics of the 9 plans change across scenarios

The least cost build plan comparison on the Business as Usual Scenario shows that the 2% EWR level along with a CCGT in 2030 is selected

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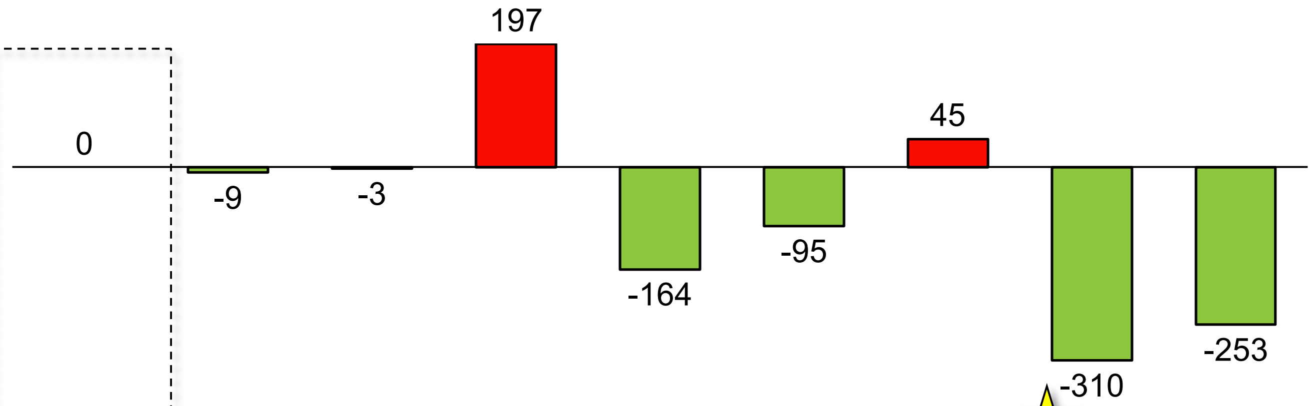
Delta NPVRR to Comparison Build Plan ($M)

Each build plan evaluated in the ***BAU Scenario***

Higher NPVRR than Comparison Plan

Lower NPVRR than Comparison Plan

★ Least Cost Plan



Least Cost Plan build from each Scenario and EWR combination		DTE REF	BAU	ET	EP	DTE & BAU	ET	EP	DTE & BAU ★	ET & EP
2029 / 2030 Resource Mix	EWR[2]	1.5%	1.5%	1.5%	1.5%	1.75%	1.75%	1.75%	2.00%	2.00%
	CCGT	414	414	414	-	414	-	-	414	-
	DR	259	167	-	216	-	167	-	-	-
	Wind	-	150	1,500	3,300	-	1,800	3,150	-	1,050
		A Comparison Build Plan[1]	B	C	D	E	F	G	H	I

1) NPVRR displayed is used to compare to a build plan that includes a combination of CCGT and DR.
2) EWR programs include Flat High Costs

The least cost build plan comparison on the DTE Reference Scenario selects CCGT and Demand Response in 2029-2030 with 1.5% EWR

DTE Energy

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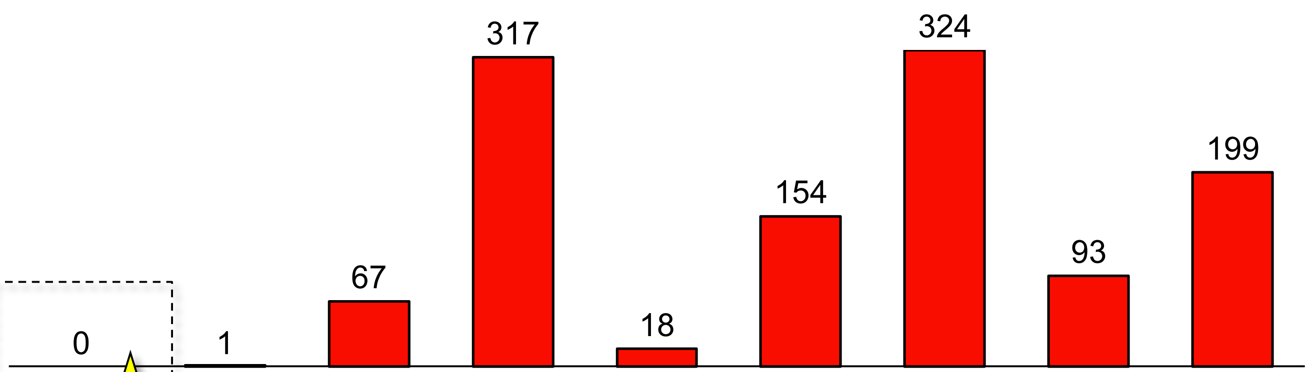
Higher NPVRR than Comparison Plan

Lower NPVRR than Comparison Plan

★ Least Cost Plan

Delta NPVRR to Comparison Build Plan ($M)

Each build plan evaluated in ***DTE's Reference Scenario***



Least Cost Plan build from each Scenario and EWR combination		DTE REF ★	BAU	ET	EP	DTE & BAU	ET	EP	DTE & BAU	ET & EP
2029 / 2030 Resource Mix	EWR[2]	1.5%	1.5%	1.5%	1.5%	1.75%	1.75%	1.75%	2.00%	2.00%
	CCGT	414	414	414	-	414	-	-	414	-
	DR	259	167	-	216	-	167	-	-	-
	Wind	-	150	1,500	3,300	-	1,800	3,150	-	1,050
		A Comparison Build Plan[1]	B	C	D	E	F	G	H	I

1) NPVRR displayed is used to compare to a build plan that includes a combination of CCGT and DR.
2) EWR programs include Tiered Costs

The least cost build plan comparison on the Emerging Technology Scenario selects the 2% EWR level with 1050 MW of wind

DTE Energy

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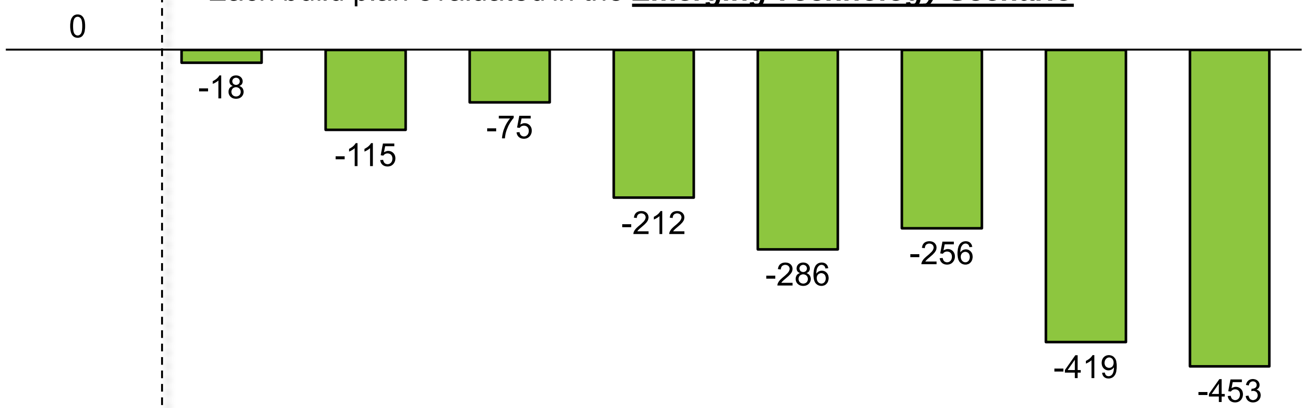
Higher NPVRR than Comparison Plan

Lower NPVRR than Comparison Plan

Delta NPVRR to Comparison Build Plan ($M)

Each build plan evaluated in the ***Emerging Technology Scenario***

★ Least Cost Plan



Least Cost Plan build from each Scenario and EWR combination		DTE REF	BAU	ET	EP	DTE & BAU	ET	EP	DTE & BAU	ET & EP ★
2029 / 2030 Resource Mix	EWR[2]	1.5%	1.5%	1.5%	1.5%	1.75%	1.75%	1.75%	2.00%	2.00%
	CCGT	414	414	414	-	414	-	-	414	-
	DR	259	167	-	216	-	167	-	-	-
	Wind	-	150	1,500	3,300	-	1,800	3,150	-	1,050
		A Comparison Build Plan[1]	B	C	D	E	F	G	H	I

1) NPVRR displayed is used to compare to a build plan that includes a combination of CCGT and DR.
2) EWR programs include Flat Low Costs

The least cost build plan comparison on the Environmental Policy Scenario selects 3,150 MW of wind with 1.75% EWR

DTE Energy

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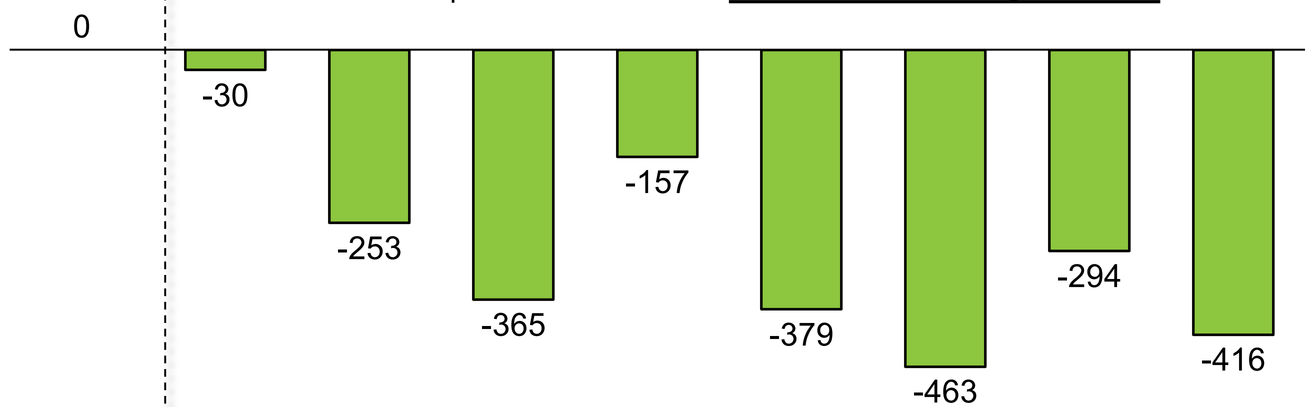
Higher NPVRR than Comparison Plan

Lower NPVRR than Comparison Plan

Delta NPVRR to Comparison Build Plan ($M)

Each build plan evaluated in the ***Environmental Policy Scenario***

★ Least Cost Plan



Least Cost Plan build from each Scenario and EWR combination		DTE REF	BAU	ET	EP	DTE & BAU	ET	EP ★	DTE & BAU	ET & EP
2029 / 2030 Resource Mix	EWR[2]	1.5%	1.5%	1.5%	1.5%	1.75%	1.75%	1.75%	2.00%	2.00%
	CCGT	414	414	414	-	414	-	-	414	-
	DR	259	167	-	216	-	167	-	-	-
	Wind	-	150	1,500	3,300	-	1,800	3,150	-	1,050
		A Comparison Build Plan[1]	B	C	D	E	F	G	H	I

1) NPVRR displayed is used to compare to a build plan that includes a combination of CCGT and DR.
2) EWR programs include Flat High Costs

Additional sensitivities have been completed including four stakeholder submitted sensitivities

DTE Energy

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	Requested / Required Sensitivities							
	A	B	C	D	E	F	G	H
Scenarios		**DTE Ref**	**DTE Ref**	**DTE Ref**	**DTE Ref**	**BAU**	**BAU**	**EP**
	Starting Point (Comparison Build)	**Demand Response**	**Stakeholder Sensitivity "N"**	**BR Retire 25/26**	**High CO2**	CT ONLY	**Choice 25%**	50% CO2
EWR Level	1.5%	1.75%	2%	1.75%	1.5%	1.5%	1.5%	1.5%
29/30 Build	414 MW 1X1 CCGT 259 MW DR	372 MW DR	Details in appendix	414 MW 1X1 CCGT 259 MW DR (2025-26 build)	4,500 MW Wind 200 MW Solar	223 MW CT (3)	None	4,800 MW Wind 100 MW Solar
Delta, $M	-	$102	N/A[1]	$74	($1,125)	$158	- - -	($749)
			External Stakeholder	*External Stakeholder*	*External Stakeholder*	*Requirement*	*External Stakeholder*	*Requirement*

- The BR Retire 25/26 represents a Strategist optimization where the existing BR plant was selected as an alternative resource. Keeping that unit operating until 2029/30 was cheaper by $74M than pulling forward DTE's reference case least cost plan from 29/30 to 25/26 (1x1 CCGT and DR)
- High levels of renewable build is more economical than a CCGT build plan in the CO_2 price sensitivities, due to the high penalty placed on CO2 emissions in both the sensitivity and the Comparison Build Run
- The Choice 25% case represents the expansion of customer choice from 10% to 25%. No additional resources are needed in this sensitivity

1) Recently received new Conservative Voltage Reduction cost estimates. Filed sensitivity will include the latest view of CVR costs

Modeling takeaways

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- The least cost plan will vary across scenarios
- Wind and EWR programs are favored in the Emerging Technology and Environmental Policy scenarios
- Using publicly available assumptions, wind is the preferred renewable alternative
- As the level of EWR savings increases, program costs become more uncertain
- Demand response resources are preferred in the DTE Reference and Business as Usual scenarios

Presentation agenda

- Energy Waste Reduction Overview
- Market Valuation Results
- Strategist Optimization Results
- **Risk Assessment Methodologies**
- Assessing Planned Levels of Renewable Penetration
- Next Steps

In addition to the Scenarios/Sensitivities analysis, four risk analysis methods will be incorporated in the IRP

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Scenarios & Sensitivities

Quantitative ⟷ *Qualitative*

Stochastic	Evaluation of Key Parameters	Change Analysis	Application of Planning Principles
• Probability distribution method • ~12 build plans will be run • 10 key drivers varied • 200 iterations per build plan	• Determine if key inputs have changed since initial model runs (i.e. energy, fuel) • Plan to update latest capacity position and run as sensitivity in all scenarios	• View of how proposed course of action performs as different futures play out • Technology advancement • Gas price variances • Load changes	• More qualitative approach • Evaluate and compare a range of plans against each of the Seven Planning Principles

After the optimization runs provide build plans, we continue to assess risks and uncertainties

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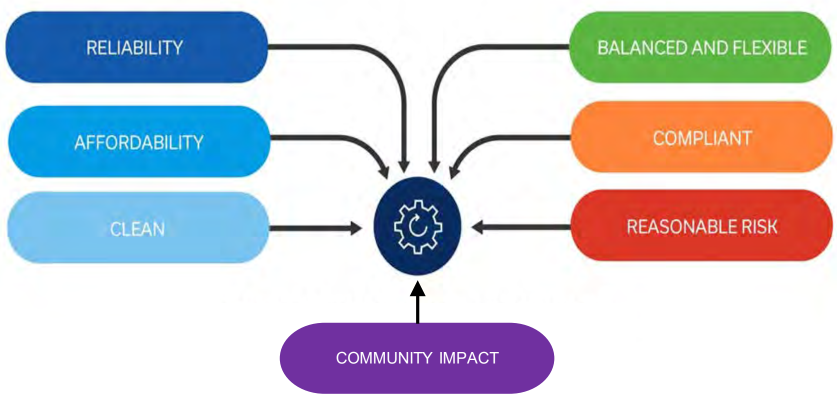

- Selected wind resource is in addition to planned renewables (starting point)
- Approval and permitting for new wind projects in the state are more challenging than before
- Per public source, wind net capacity factor increases over the study period[1]
- MISO capacity credit for solar is forecasted to decline over time[2]
- Optimization modelling does not assume curtailment or congestion constraints, so all excess energy is sold into the market
- Need to fully understand potential reliability impacts with increasing renewable penetration

Least Cost Plan build from Scenario		DTE REF	BAU	ET	EP	DTE & BAU	ET	EP	DTE & BAU	ET & EP
2029 / 2030 Resource Mix	EWR[2]	1.5%	1.5%	1.5%	1.5%	1.75%	1.75%	1.75%	2.00%	2.00%
	CCGT	414	414	414	-	414	-	-	414	-
	DR	259	167	-	216	-	167	-	-	-
	Wind	-	150	1,500	3,300	-	1,800	3,150	-	1,050
		A	B	C	D	E	F	G	H	I

1. Source: NREL 2018 Annual Technology Baseline (ATB); Net Capacity Factor increase from 34% to 38% through 2030, increase to 41% through 2040
2. Source: MTEP 19 Futures, Planning Advisory Committee (June 13, 2018); 50% Effective Load Carrying Capability through 2023, decline at 2% per year until 2033

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Michigan's electric system is expected to undergo a significant transition in the decades to come

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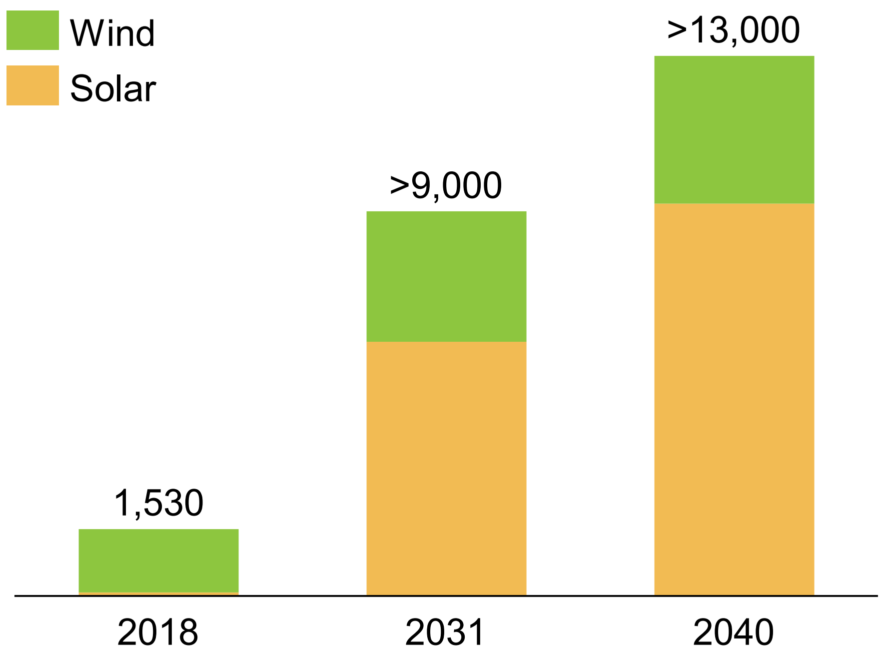
Renewable Generation Capacity
Installed Capacity in MISO Zone 7 (MW)



- Michigan's electric system will see significantly investments in renewables in the decades to come as both DTE and Consumers Energy follow their goals to reduce carbon emissions from their systems
- At the same time, the amount of dispatchable 24x7 resources are projected to decline significantly as coal units retire
- This raises a set of resource adequacy and operational challenges that will need to be analyzed in order to ensure that the impacts on customer reliability are fully understood and any potential risks properly mitigated

We have engaged The Brattle Group to gain a better understanding of the implications of higher levels of renewables in Michigan

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Overview of The Brattle Group

- The Brattle Group provides clients with regulatory, economic consulting, business strategy, and expert testimony before regulatory agencies, courts, and arbitration panels
- Brattle offers a combination of technical modeling capabilities, rich understanding of interrelationships among market factors, and practical and thoughtful application of models to problems
- The company has significant experience supporting system planning using resource adequacy simulation, and have capacity market models developed based on their experience reviewing and helping to design these markets for the RTOs that have them
- Sample clients include:

PUCN Public Utility Commission of Nevada

California ISO

ercot

ONCOR Electric Delivery

Scope of Modeling Work

- The Brattle Group evaluated Michigan's projected electric system in 2031 and 2040, based on the generation investments and retirements laid out in CMS's and DTE Energy's IRPs
- Modeling work covered both resource adequacy simulations and operational simulations[1]
- Results of the modeling work are used to discuss resource adequacy and reliability outcomes in the scenarios modeled and the risks around them, as well as the role that various dispatchable assets (including energy storage) play in keeping the system operable
- **The Brattle Group study's findings will be captured in a white paper that will be submitted with DTE's IRP filing in late March**

1. The latter used a production cost model better capable of capturing some of the potential integration challenges emerging at higher levels of renewable penetration than tools currently used by DTE. Said tool modeled both day-ahead and real-time markets in 10-minute intervals.

Presentation agenda

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- **Next Steps**

Next Steps

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- Continue to review modeling results and perform quality checks
- Complete additional risk assessment steps
- Finalize the Proposed Course of Action
- File the IRP with the Michigan Public Service Commission by March 29, 2019

Break

Text **DTECOMMENTS to 37607** for questions or comments as they arise during the presentation. You will get a text confirming that you have joined the session. (**Please limit questions and comments to 1 per text)**

If using laptop or tablet respond using **pollev.com/dtecomments** (**Please limit questions and comments to 1 at a time)**

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Questions on Presentation

Stakeholder Comments on IRP Process

Closing Remarks

Appendix

Market valuations ranking by technology

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DTE Reference	
Real Time Pricing	2.88
Variable Peak Pricing	2.65
CVR	2.65
1.5% EWR	1.92
Time of Use	1.71
Demand Buyback	1.36
Advanced CCGT (1x1)	1.12
1.75% EWR	0.99
Wind	0.96
Solar	0.93
Advanced CT	0.89
2.0% EWR	0.88

Business As Usual		Business As Usual – High Gas	
Real Time Pricing	1.99	1.75% EWR	2.29
Variable Peak Pricing	1.84	1.5% EWR	2.23
1.75% EWR	1.66	2.0% EWR	2.20
1.5% EWR	1.64	Wind	1.48
2.0% EWR	1.54	Solar	1.36
Time of Use	1.19	Advanced CCGT (1x1)	1.06
Advanced CCGT (1x1)	1.10	Advanced CT	0.88
Wind	1.04	Real Time Pricing	0.47
Solar	0.97	Variable Peak Pricing	0.43
Demand Buyback	0.95	Time of Use	0.28
Advanced CT	0.92	Demand Buyback	0.22

DTE Reference - High CO2	
Real Time Pricing	3.40
Variable Peak Pricing	3.14
1.5% EWR	2.84
Time of Use	2.02
Demand Buyback	1.61
Wind	1.50
1.75% EWR	1.48
Solar	1.43
2.0% EWR	1.35
Advanced CCGT (1x1)	1.26
Advanced CT	0.98

Emerging Technology		Environmental Policy	
1.75% EWR	2.03	1.75% EWR	1.58
1.5% EWR	1.97	1.5% EWR	1.56
2.0% EWR	1.94	2.0% EWR	1.48
Real Time Pricing	1.31	Wind	1.37
Solar	1.28	Solar	1.28
Variable Peak Pricing	1.20	Real Time Pricing	1.07
Wind	1.16	Advanced CCGT (1x1)	1.06
Advanced CCGT (1x1)	1.06	Variable Peak Pricing	0.98
Advanced CT	0.88	Advanced CT	0.87
Time of Use	0.78	Time of Use	0.63
Demand Buyback	0.62	Demand Buyback	0.51

Demand Response	Combined Cycle / Combustion Turbine	Energy Waste Reduction	Wind	Solar

Summary of the Stakeholder Sensitivity "N" run on the DTE Reference Scenario

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	Sensitivity
1. Load Growth	DTE Forecast + 24% EV sales by 2030 (Bloomberg)
2. EWR	2.0% annually through all years unless more is required to meet #9
3. Capital Cost	DTE CCGT cost
4. Renewable	50% Clean Energy Goal (35% renewable by 2030)
5. Gas Price	DTE Reference case
6. Retirement	DTE Plan
7. Demand Response	Full amount from 2017 State of MI Potential Study (high case)
8. Distributed renewables	+450MW
9. Available replacement	Defer second CCGT with EWR, DR, and renewables
10. Conservation Voltage Reduction	150MW by 2028

No capacity needed in 2030 for this sensitivity

The results of the High Gas sensitivities are shown below

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Delta NPVRR shown compares back to a build plan that includes a 1x1 CCGT and DR in 29/30
"Flat high cost" refers to DR assumptions of 50% incentive levels

	LEAST COST PLAN -BAU_HIGH GAS -FLAT HIGH COST				
EWR Level	1.50%	1.75%	2.00%	2.25%	2.50%
29/30 Build	4200 MW Wind, 300 MW Solar	3150 MW Wind	1050 MW Wind	450 MW Wind	-
PVRR, $M	$13,105,198	$12,995,692	$13,344,729	$13,807,732	$15,576,388
Delta, $M	($1,290)	($1,400)	($1,051)	($588)	$1,181

	LEAST COST PLAN -EP_HIGH GAS -FLAT HIGH COST				
EWR Level	1.50%	1.75%	2.00%	2.25%	2.50%
29/30 Build	5100 MW Wind	3150 MW Wind	1050 MW Wind	450 MW Wind	-
PVRR, $M	$12,524,670	$12,692,216	$13,335,239	$13,878,051	$15,712,371
Delta, $M	($1,969)	($1,801)	($1,158)	($615)	$1,219

	LEAST COST PLAN -ET_HIGH GAS -FLAT HIGH COST				
EWR Level	1.50%	1.75%	2.00%	2.25%	2.50%
29/30 Build	4500 MW Wind 200 MW Solar	3150 MW Wind	1050 MW Wind	450 MW Wind	-
PVRR, $M	$12,629,251	$12,565,462	$12,941,530	$13,282,481	$14,510,375
Delta, $M	($1,492)	($1,556)	($1,180)	($839)	$389

DTE Electric utilizes Planning Principles in our IRP Process

RELIABILITY	Each plan analyzed is required to meet the reliability planning requirements established by MISO and to encompass our desire to maintain a reliable fleet in the face of aging coal units.
AFFORDABILITY	Affordability is measured by the yearly impacts to the revenue requirement
CLEAN	Environmental sustainability, low carbon aspirations, and clean energy goals are major factors in the determination of the recommended resource portfolio
FLEXIBLE AND BALANCED	The resource plan needs to be flexible, having the ability to adapt to unforeseen changes in the market. Additionally, it must have a well balanced mix of resources so that it is not heavily reliant on the market or one source of generation
COMPLIANT	All resource plans are modeled to be compliant with the IRP filing requirements as well as environmental regulations
REASONABLE RISK	The Company desires a portfolio that minimizes risks related to commodity and market pricing, fuel availability, grid reliability, capacity constraints, operations and evolving regulations
COMMUNITY IMPACT	Considerations of the aspects of employment, tax base, and other community impacts

Glossary of Integrated Resource Planning and modeling terms and acronyms

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Term	Definition	Term	Definition
ADV	Advanced (class of Combined cycles)	Flat Low	Energy Waste Reduction cost level based on 35% incentive levels
BAU	Business as Usual	GDS	GDS Associates, a consulting firm that studies Energy Waste Reduction
BLRPP	Belle River Power Plant	IAC	Interruptible Air Conditioning, a Demand Response program
C&I	Commercial and Industrial	IRP	Integrated Resource Plan
CCGT	Combined Cycle Gas Turbine	ITC	Investment Tax Credit, associated with Solar
CCS	Carbon Sequestration and Storage	LCP	Least Cost Plan (from optimization)
CT	Combustion Turbine	MISO	Midcontinent Independent System Operator
CVR	Conservation Voltage Reduction	MPSC	Michigan Public Service Commission
DLC	Direct Load Control	MW	Megawatt, can be used in terms of capacity or size of alternative
DR	Demand Response	NPVRR	Net Present Value of the Revenue Requirement
DTE	DTE Energy (in this context, the DTE Reference Scenario)	PTC	Production Tax Credit, associated with wind
EP	Environmental Policy Scenario	RICE	Reciprocating Internal Combustion Engine
ET	Emerging Technology Scenario	SME	Subject Matter Expert
EV	Electric Vehicles	Tiered	Energy Waste Reduction cost level based on 35% incentive level for first 1.5% and 50% incentive levels for 2.0%
EWR	Energy Waste Reduction	UCAP	Unforced unit Capacity (credit from MISO)