Application of Machine Learning and BIM in Energy Analysis

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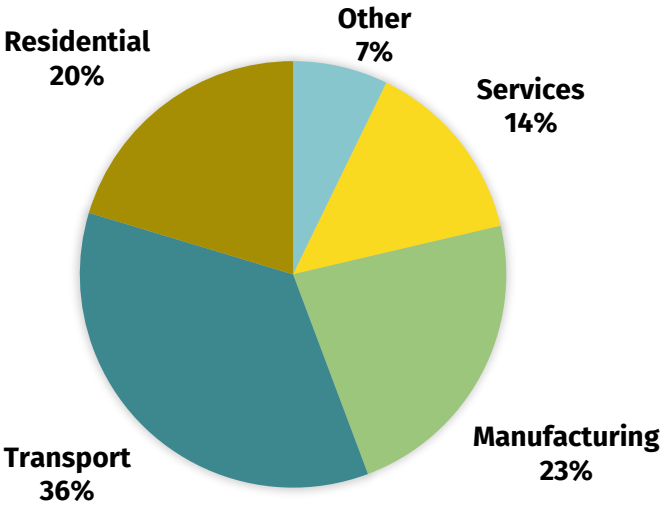
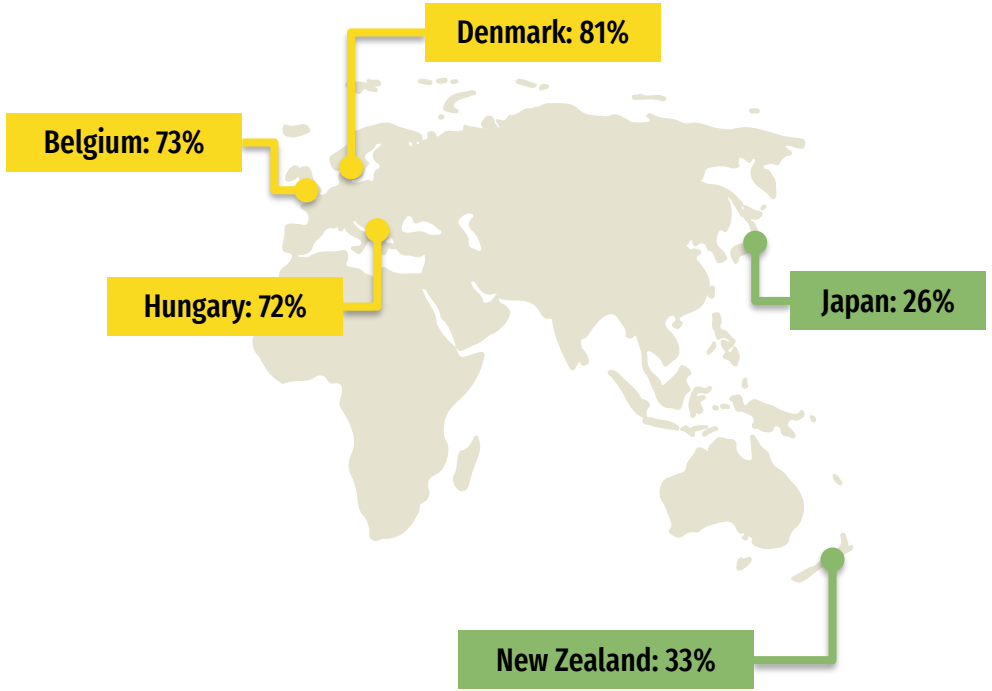
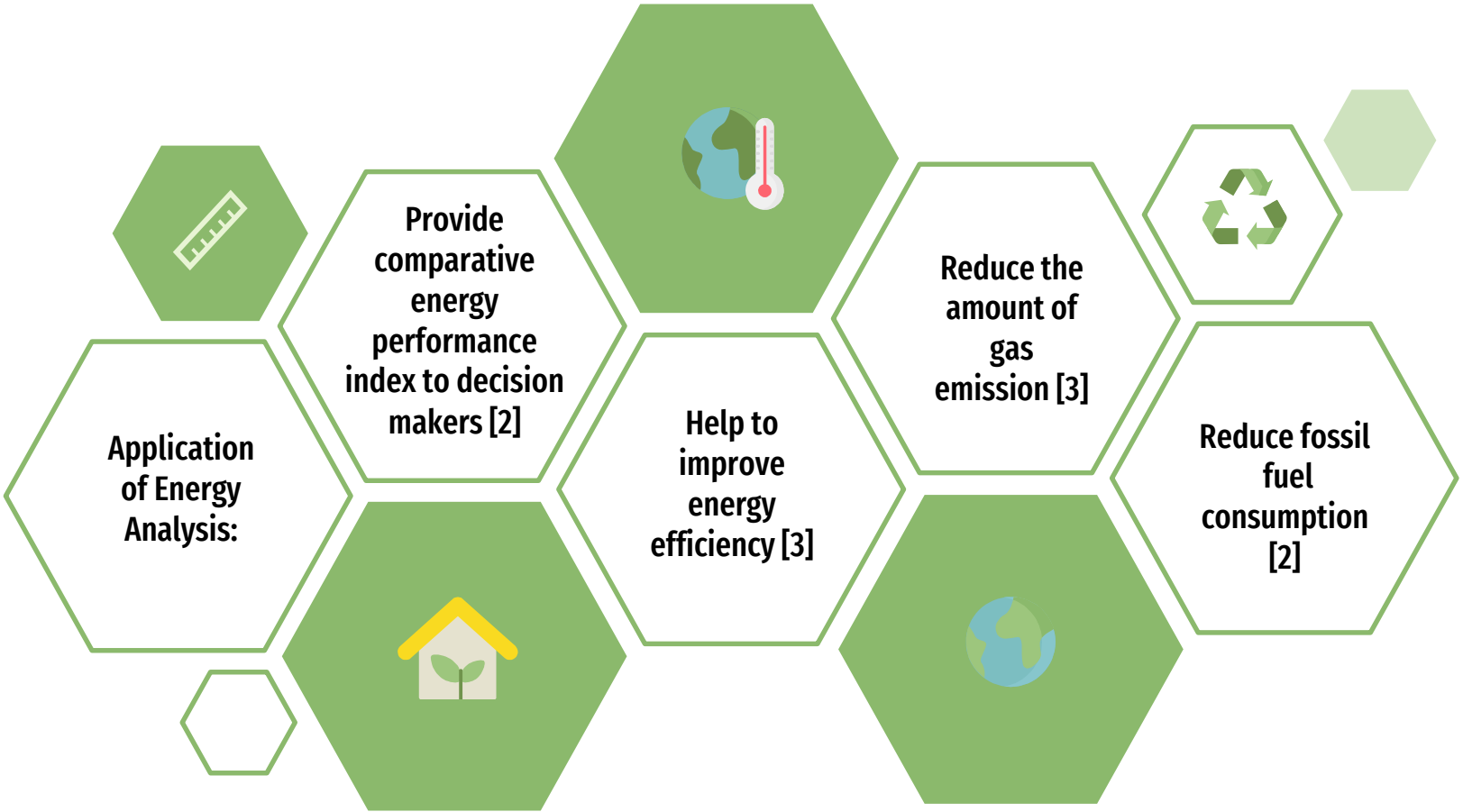
Introduction

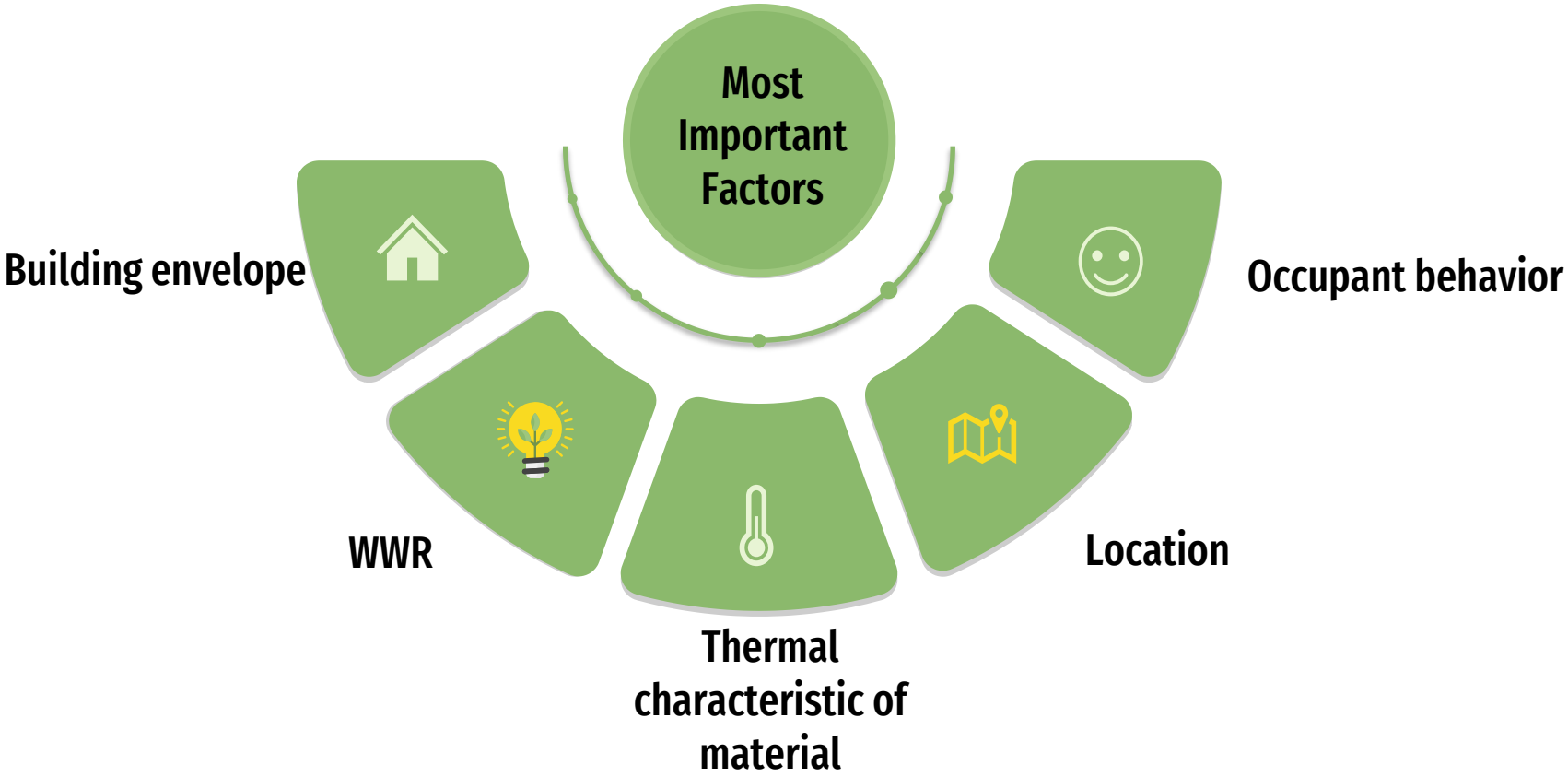


Largest end uses of energy by sector, selected IEA countries, 2019[1]

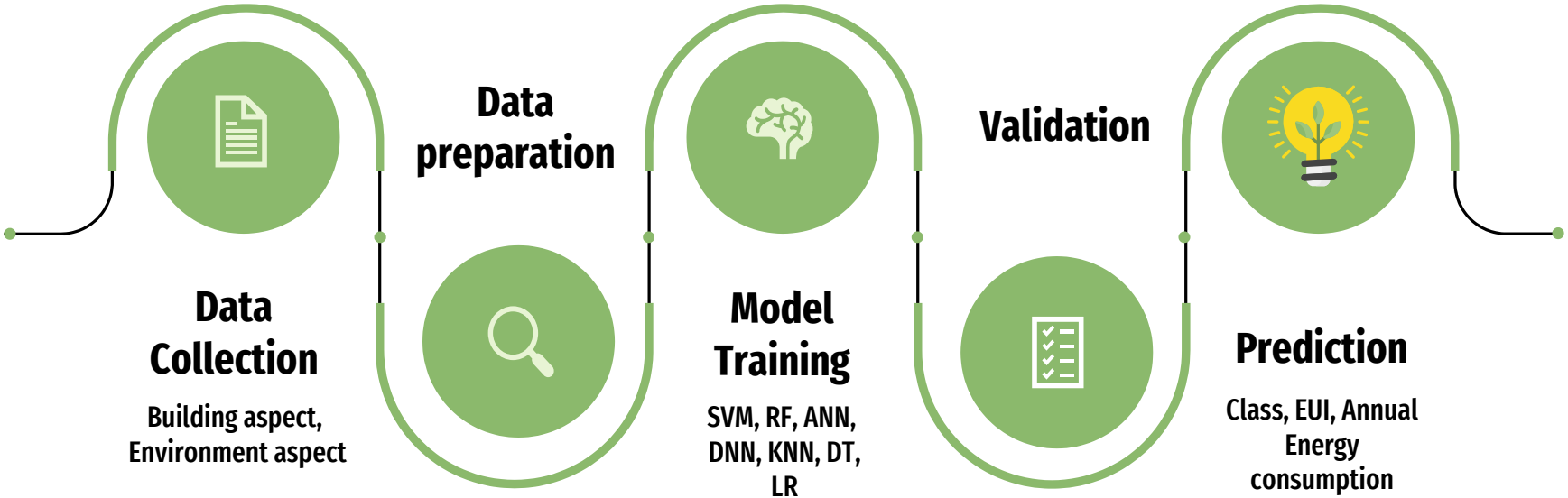
Space heating Shares of residential energy consumption [1]




Application of Energy Analysis:
Provide comparative energy performance index to decision makers [2]
Help to improve energy efficiency [3]
Reduce the amount of gas emission [3]
Reduce fossil fuel consumption [2]

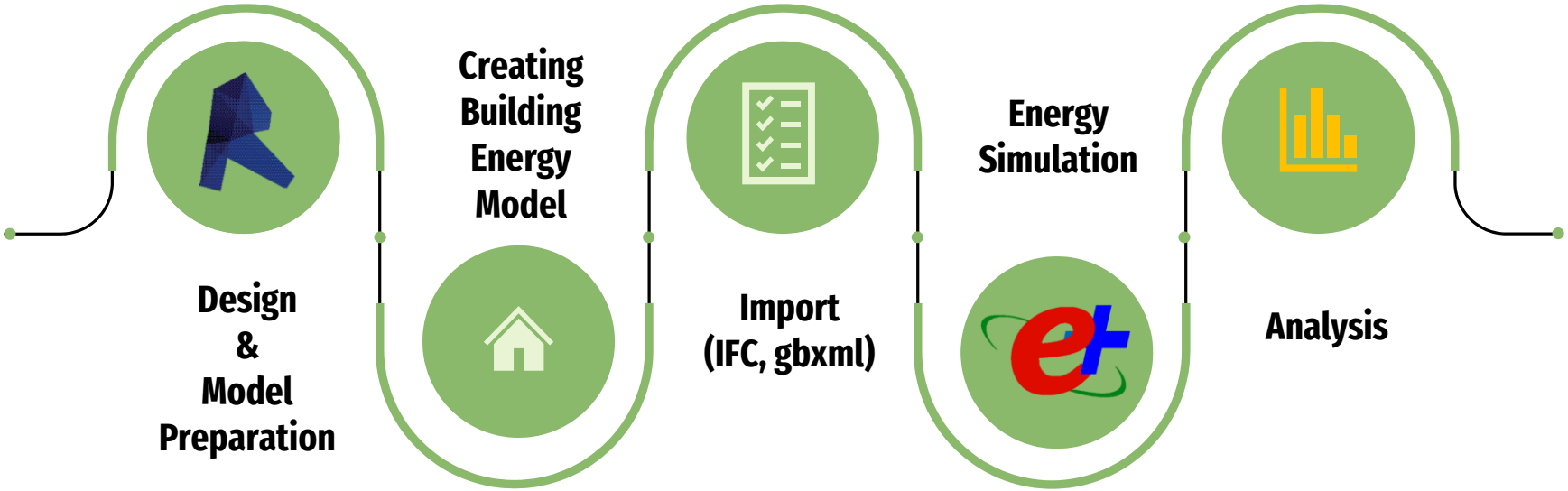

Most Important Factors
Building envelope
Occupant behavior
WWR
Location
Thermal characteristic of material

Machine Learning in Energy Analysis



Reference	Data	ML							Building	Purpose	REF
		RF	SVM	KNN	ANN	DNN	DT	LR			
Razak Olu-Ajayi et al (2022)	Real	✓	✓	✓	✓	✓	✓	✓	Residential	Energy Consumption	[4]
Yang Liu et al (2021)	Simulation	✓	✓		✓				Non-residential	Energy Efficiency	[5]
Jun Ma, Jack C.P. Cheng (2016)	Real	✓						✓	Residential	Energy Efficiency	[6]
Minglei Shaoa et al (2020)	Real		✓						Non-residential	Energy Consumption/ efficiency	[7]

BIM in Energy Analysis

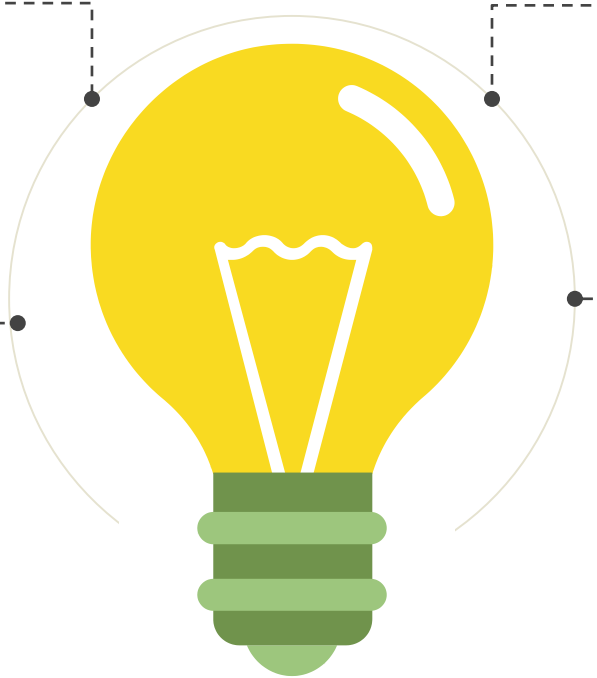


Reference	BIM	BEM						Building	Purpose	REF
		Energy Plus	GBS	Insight	Open Studio	IES VE	First Rate5			
Mikhail Demianenko et al (2021)	Revit		✓					Residential	Energy consumption	[8]
Ehsan Kamel, Ali M. Memari (2018)	Revit	✓			✓			Residential	Energy Efficiency	[9]
Quddus Tushar et al (2021)	Revit						✓	Residential	Energy Efficiency	[10]
Georgios Gourlis, Iva Kovacic (2017)	Revit	✓						Non-residential	energy consumption/ efficiency	[11]

Conclusion

Occupant Behavior

Insufficiency of Data



A standard for data exchange process

Different Building classification

References:

[1] IEA. (2021). *Energy Efficiency Indicators*. Available: https://www.iea.org/reports/energy-efficiency-indicators-overview

[2] S. Seyedzadeh, F. P. Rahimian, I. Glesk, and M. Roper, "Machine learning for estimation of building energy consumption and performance: a review," *Visualization in Engineering,* vol. 6, no. 1, pp. 1-20, 2018.

[3] Y.-T. Chen, E. Piedad Jr, and C.-C. Kuo, "Energy consumption load forecasting using a level-based random forest classifier," *Symmetry,* vol. 11, no. 8, p. 956, 2019.

[4] R. Olu-Ajayi, H. Alaka, I. Sulaimon, F. Sunmola, and S. Ajayi, "Building energy consumption prediction for residential buildings using deep learning and other machine learning techniques," *Journal of Building Engineering,* vol. 45, p. 103406, 2022

[5] Y. Liu, H. Chen, L. Zhang, and Z. Feng, "Enhancing building energy efficiency using a random forest model: A hybrid prediction approach," *Energy Reports,* vol. 7, pp. 5003-5012, 2021.

[6] J. Ma and J. C. Cheng, "Identifying the influential features on the regional energy use intensity of residential buildings based on Random Forests," *Applied energy,* vol. 183, pp. 193-201, 2016.

[7] M. Shao, X. Wang, Z. Bu, X. Chen, and Y. Wang, "Prediction of energy consumption in hotel buildings via support vector machines ",*Sustainable Cities and Society,* vol. 57, p. 102128, 2020.

[8] M. Demianenko and C. I. De Gaetani, "A Procedure for Automating Energy Analyses in the BIM Context Exploiting Artificial Neural Networks and Transfer Learning Technique," *Energies,* vol. 14, no. 10, p. 2956, 2021.

[9] E. Kamel and A. M. Memari, "Automated building energy modeling and assessment tool (ABEMAT)," *Energy,* vol. 147, pp. 15-24, 2018.

[10] Q. Tushar, M. A. Bhuiyan, G. Zhang, and T. Maqsood, "An integrated approach of BIM-enabled LCA and energy simulation: The optimized solution towards sustainable development," *Journal of Cleaner Production,* vol. 289, p. 125622, 2021

[11] G. Gourlis and I. Kovacic, "Building Information Modelling for analysis of energy efficient industrial buildings–A case study," Renewable and Sustainable Energy Reviews, vol. 68, pp. 953-963, 2017.