Realising Europe's efficiency pipeline

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Abstract
The Ukraine crisis has raised the importance of energy security in Europe. In the EU Energy Security Strategy, moderating demand is a strategic tool to increase energy security; however, the primary focus remains on supply-side options. And while political support for energy efficiency has grown somewhat, an ambitious policy target in Brussels has not emerged in the wake of concerns brought on by the events in Ukraine.

Yet energy efficiency, particularly in buildings, should be a front-running strategy to address European energy security. In Europe, buildings account for about 40 % of energy use and more than a third of natural gas use. Energy efficiency can be viewed as a "pipeline" that delivers reliable, cost-effective services, just like a natural gas pipeline delivers the fuel service for heat and hot water. Unlike natural gas (or other conventional energy sources), however, energy efficiency burns no fuel and emits no pollution. And it is a domestically sourced resource that reduces both import dependency and reliance on fossil fuels, which is essential to meeting Europe's climate and energy security objectives. And even amidst uncertainty over the potential magnitude of rebound effects triggered by efficiency improvements, increasing the productivity with which energy resources are utilised means that Europe can get more energy services out of its resources than ever before. In this way, energy efficiency can also be an important driver for Europe's economic growth.

The purpose of this paper is to introduce key steps for building a strong "efficiency pipeline" that can deliver these benefits, particularly in the context of Europe's energy security challenges. The paper begins with a discussion of energy security in Europe, followed by an overview of the potential of energy efficiency in buildings to reduce energy use and natural gas dependency. Next, it describes the concept of the efficiency pipeline and the importance of an "Efficiency First" approach in energy regulation and infrastructure planning to ensure that Europe meets its energy security needs with the most cost-effective mix of resources. Finally, the discussion draws on international experiences with Efficiency First in developing preliminary recommendations and areas for further inquiry in Europe.

Energy security in Europe
In 2014, Russia annexed the Crimean peninsula, raising concerns over further aggression from Moscow and fomenting civil unrest within Ukraine. The situation has raised international alarm over Russia's intentions and the stability of the region, and led to political tensions between Russia and Europe. It has also resurrected questions over the security of gas supply to Europe. About 50–60 % of Russian natural gas exports to Europe flow through Ukraine, meaning dire consequences if supply is disrupted, particularly in the winter heating season. In the past, disputes between Russia and Ukraine have led to supply cut-offs – most recently in 2009, when the flow of gas to Europe through Ukraine was completely blocked for some time.[1]

In its 2014 communication on energy security (COM(2014) 330 final), the European Commission lists dependence on a single, external supplier as the biggest threat to Europe's energy security. Today, Europe imports 53 % of the energy it con-

1. US Energy Information Administration (EIA). (2014, March 14). *16 % of natural gas consumed in Europe flows through Ukraine* [Web page]. Retrieved from http://www.eia.gov/todayinenergy/detail.cfm?id=15411.

sumes, including almost 90 % of its oil, 66 % of its natural gas, 42 % of solid fuels, and 40 % of nuclear fuel. The gas sector is particularly vulnerable, as 39 % of all natural gas consumed in Europe comes from Russia, which over the past several years has been an unreliable supplier.[2]

In response to the Russian gas crisis in 2009, Europe activated a number of strategies to increase supply security, including a renewed push for gas market liberalisation and integration, as well as new gas storage requirements and reverse flows. In spite of these measures, Europe remains vulnerable to gas supply shocks and in particular to supply curtailments from Russia. This is especially true for countries in Central and Eastern Europe, which not only have the lowest levels of market liberalisation and integration, but are most dependent on Russia for their supply.[3] The region also has some of Europe's lowest levels of energy efficiency in buildings. As indigenous gas supply continues to decline over the coming years, Europe will be increasingly reliant on imports to meet demand.[4]

While reliance on imported natural gas or on a single supplier is the aspect of security of supply that has garnered the most recent attention, there are other vital criteria to consider as Europe shapes its energy strategy. Reliable operation of the energy system is also essential to the secure provision of energy services to end-use customers, and doing so at lowest cost to consumers is an important objective of the Third Energy Package. Moreover, environmental integrity of the energy system is a central tenet of European policy, and one that is increasingly linked to economic growth and competitiveness.

As Europe considers how to secure its energy future, it is important to ensure a proper balance among these various considerations. Today, the European Commission is shaping its shared objectives in the framework of the "Energy Union."[5] As part of this exercise, it is taking a hard look at the governance system underpinning energy policy, and deploying a work plan for the specific instruments that will guide and deliver development of the energy system over both the short and long term. This provides an opportunity to reassess how energy efficiency is integrated into energy sector regulations, policies, infrastructure planning and governance. And, importantly, it is a time to recognise energy efficiency as an essential element to improve Europe's goals concerning energy security, competitiveness, and sustainability.

Buildings: Role and potential

In Europe, buildings are responsible for about 40 % of overall energy consumption — more than any other sector — and, as a result, are an integral part of the energy system.[6] They are also a major consumer of natural gas in Europe, accounting for about 40 % of gross inland consumption, primarily for space and hot water heating. In fact, 61 % of all imported gas is consumed by the building sector.[7] And while buildings are a major energy consumer, they also represent a major potential source of energy savings. In fact, as discussed below, only a small portion of the energy savings potential in buildings is being realised. Ramping up energy efficiency in buildings, therefore, has the potential to significantly reduce energy consumption while also reducing reliance on fossil fuels, including imported natural gas.[8]

The bulk of natural gas savings potential lies in reducing demand for heat and hot water in existing buildings. More than 80 % of residential buildings in Europe were constructed before 1990, including more than 40 % constructed before 1960.[9] And about 80 % of all energy consumed in buildings is for space and water heating.[10] The sources of heat and hot water vary across the EU, and include electricity, gas, district heat (which can include coal, gas, or other fuel sources), and to a smaller extent coal stoves, wood and wood products. However, on average, natural gas continues to be the largest energy source in buildings in the EU, accounting for 37 % of household energy consumption in 2012.[11]

A number of recent studies have looked at the potential for reducing energy consumption in buildings in Europe. The table below presents a high-level overview of the findings from several of these studies. It is difficult to compare results, given the different assumptions that went into the modelling, and different ways in which crucial elements of the studies were organized such as scenarios, discount rates, etc. Nevertheless, it is worth noting that the savings potentials to 2030 and 2050 are significant and that they are unlikely to be met with current policies and programmes.

The significant energy savings potential in buildings translates into meaningful natural gas savings and associated energy security benefits. The European Commission in its impact assessment to the energy efficiency communication in July 2014 found that every 1 % in additional (economy-wide) energy savings translates into a 2.6 % reduction in natural gas imports.[12] The Ecofys analysis, which analysed the potential of building renovations to increase energy security, yielded a reduction of gas consumption in the building sector of 95 % by 2050 in their deep renovation scenario. Theoretically, the building sector could reduce its own gas and oil imports by 20 % by 2020, 60 %

2. European Commission. (2014a). *Communication on European energy security strategy*. COM(2014) 330 final. Retrieved from http://www.europarl.europa.eu/meetdocs/2014_2019/documents/itre/dv/com_com%282014%290330_/com_com%282014%290330_en.pdf.

3. European Commission, 2014a.

4. Ibid., pp. 12–13.

5. European Commission. (2015). *Energy Union Package*. COM(2015) 80 final. Retrieved from http://eur-lex.europa.eu/resource.html?uri=cellar:1bd46c90-bdd4-11e4-bbe1-01aa75ed71a1.0001.03/DOC_1&format=PDF.

6. European Environment Agency. (2015, January). *Final energy consumption by sector and fuel*. CSI 027/ENER 016. Retrieved from http://www.eea.europa.eu/data-and-maps/indicators/final-energy-consumption-by-sector-8/assessment-2.

7. Bettgenhäuser, K., de Vos, R., Grözinger, J., and Boermans, T. (2014, May 20). *Deep renovation of buildings: An effective way to decrease Europe's energy import dependency*, p. 4. Cologne, Germany: Ecofys. Retrieved from http://www.ecofys.com/files/files/ecofys-eurima-2014-deep-renovation-of-buildings.pdf.

8. Neme, C., Gottstein, M., and Hamilton, B. (2011, May). *Residential Retrofits: A Roadmap for the Future*. Montpelier, VT: The Regulatory Assistance Project. Retrieved from http://www.raponline.org/docs/RAP_Neme_ResidentialEfficiencyRetrofits_2011_05.pdf.

9. Buildings Performance Institute Europe (BPIE). (2011). *Europe's Buildings Under the Microscope*. Retrieved from http://www.bpie.eu/uploads/lib/document/attachment/21/LR_EU_B_under_microscope_study.pdf.

10. Lapillonne, B., Sebi, C., Pollier, K., and Mairet, N. (2012, September) *Energy Efficiency Trends for Households in the EU*. Retrieved from http://www.odyssee-mure.eu/publications/br/Buildings-brochure-2012.pdf.

11. Lapillonne, et al., 2012.

12. European Commission. (2014b). *Impact Assessment*. SWD(2014) 255 final. Retrieved from http://ec.europa.eu/energy/efficiency/events/doc/2014_eec_ia_adopted_part1.pdf.

Table 1. Energy savings potential studies (buildings) for 2030 and 2050.

Report	2030	2050	Scenario
Buildings Performance Institute Europe (BPIE) [a]	Up to 36 % reduction in existing buildings (compared to 2010) [b]	Up to 68 % reduction in existing buildings (2010)	"Deep renovation": Average renovation rate of 2.5 % per year.
Ecofys[c]		75 % reduction final energy use (2010)	"Deep renovation": Rate of 2.3 % of building stock, with high focus on efficiency of building envelope and high use of renewable energy.
EU, Energy Security Strategy[d]	Up to 40 % (residential) and 49 % (tertiary) – decrease over BAU projections, based on PRIMES 2007	Up to 55 % (residential) and 51 % (commercial) decrease over BAU projections, based on PRIMES 2007	Six scenarios modelled with primary energy reductions of 27 %, 28 %, 29 %, 30 %, 35 %, 40 %, relative to PRIMES 2007 projections.
Fraunhofer Institute[e]	15–37 % reduction (residential) 20–41 % reduction (tertiary) (compared to 2008)		This range covers the Baseline Including Early Actions scenario up to the Near Economic scenario. Baseline Including EA includes policy measures that were adopted between 2008 and 2014. Near Economic assumes measures that are not economic but induce costs not much higher than present level of energy consumption entails.
Entranze[f]	28–42 % final delivered energy savings (residential) 22–33 % final delivered energy savings (tertiary) (space and water heating, compared to 2008)		The lower end represents the savings potential in a low policy scenario, with moderate policy ambition with moderate level of subsidies, available budget, and low energy prices. The higher end represents potential in a high policy ambition scenario and with high energy prices.

[a] *BPIE, 2011.*

[b] *Model used for BPIE's Europe's Buildings under the Microscope report (2011), run until 2030, all assumptions and input factors as described in report.*

[c] *de Vos, R., van Breevoort, P., Hagemann, M., and Höhne., N. (2014, October). Increasing the EU's Energy Independence, A no-regrets strategy for energy security and climate change. Ecofys. Retrieved from http://www.ecofys.com/files/files/ecofys-ocn-2014-increasing-the-eu-s-energy-independence.pdf.*

[d] *European Commission. (2014b). Impact Statement. SWD(2014) 255 final. Retrieved from http://ec.europa.eu/energy/efficiency/events/doc/2014_eec_ia_adopted_part1.pdf.*

[e] *Braungardt et al. (2014). Study evaluating the current energy efficiency policy framework in the EU and providing orientation on policy options for realising the cost-effective energyefficiency/saving potential until 2020 and beyond. Report for DG ENER: Fraunhofer Institute, TU Vienna, and PricewaterhouseCoopers. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/2014_report_2020-2030_eu_policy_framework.pdf.*

[f] *Entranze Scenario Data. (n.d.). Retrieved from http://www.entranze-scenario.enerdata.eu/site/.*

by 2030, and 100 % by 2050 through deep renovation combined with renewable energy inputs.[13]

A critical comparison of these potential studies is beyond the scope of this paper. However, collectively the findings in the above reports on the potential for energy savings support the observation that there is significant, untapped potential to achieve energy savings in buildings in Europe. And, as the Ecofys report and European Commission's own analyses show, realising this potential can significantly improve European energy security through decreased gas imports. Increasing the uptake of energy efficiency in buildings, however, will require ramping up ambition on energy efficiency by strengthening the policies and programmes driving energy efficiency investment. It will also require re-aligning energy regulation and planning to actively evaluate the cost-effectiveness and value of demand-side resources (which include energy efficiency, demand response and generation on the customer-side of the meter) before committing to investments in supply-side infrastructure.

The next section turns to how Europe can better integrate energy efficiency and other demand-side resources into how investments are prioritised in the energy sector, and in particular in the natural gas sector.

13. Bettgenhäuser et al., 2014.

The efficiency pipeline

INTRODUCTION

The efficiency pipeline represents the aggregate potential of energy efficiency to reduce reliance on natural gas in Europe. It recognises the role of energy efficiency as a resource that can deliver reliable, cost-effective services, just like a natural gas pipeline delivers the fuel service for heat and hot water. Much of this potential lies in improving the efficiency of heating and hot water in the building sector.

Actualising Europe's efficiency pipeline requires strengthening of existing policies and programmes that drive energy efficiency, including building codes, appliance standards, energy labelling, and cross-cutting policies such as energy efficiency obligations (EEOs) under Article 7 of the Energy Efficiency Directive. Crucially, it also requires energy efficiency to be integrated as an energy resource into energy markets, regulation, and infrastructure planning. Currently, energy efficiency is most often treated as a "separate but important" element of Europe's energy policy. However, this means that at essential junctures where decisions are made on resource needs and investments, opportunities to reduce costs in supply-side investments through demand-side investments are overlooked.

This paper addresses the importance of realigning how we think about energy infrastructure investments to take account of the potential of demand-side resources to help meet system needs. In particular, it looks at ways that that energy efficiency can be evaluated as an option alongside supply-side options in the regulated portions of the energy system – the "pipes" and "wires."[14] It looks at experience with, and opportunities for, identifying the cost-effective potential for efficiency to reduce the need for investments in more expensive infrastructure, thereby streamlining public funding and private finance to achieve the optimal balance of supply- and demand- side resources. While this paper focuses on the natural gas sector, we also refer to the electricity sector due to the many parallel opportunities to introduce similar policies in both sectors, as well as the fact that much of the experience with demand-side alternatives to supply-side resources have originated in the electricity sector.

Failing to account for the potential of energy efficiency ignores opportunities to meet system and related security needs at lower cost to consumers, the environment and the economy as a whole.[15] Experience with energy efficiency and other demand-side resources has demonstrated that energy efficiency can, among other things:

- Defer or avoid the need for new transmission and distribution infrastructure or upgrades;[16]
- Lower gas commodity prices and capacity and storage costs due to a reduction in overall natural gas consumption;[17]
- Increase reliability by reducing congestion in transmission and distribution pipelines, in particular lowering transmission and distribution losses at peak times;
- Avoid the need to expand natural gas supply.[18]

Conversely, failing to account for energy efficiency when decisions are being made concerning the need for new or upgraded infrastructure can potentially lock in costs in a number of ways:

- Result in over-sized pipes or wires;
- Lead to infrastructure that may not have been needed if energy efficiency had been considered first, such as pipelines and LNG ports;
- Lock in additional long-term contracts for natural gas at higher volumes than will be required in the future.

Moreover, investing in energy efficiency has several benefits over investments in the natural gas sector that, while difficult to quantify, argue for considering demand-side resources before committing supply-side investments. For example, while natural gas projects tend to involve large capital outlays and several years to completion, energy efficiency can be rolled out more quickly and incrementally, allowing for course corrections over time. Natural gas infrastructure projects lock in customers to natural gas prices, which can be unpredictable over time. Energy efficiency, on the other hand, generates no emissions, and is not dependent on fuel costs to generate savings.[19] Lastly, Europe is expected to become increasingly dependent on natural gas imports as domestic resources continue to diminish, and shale gas prospects remain uncertain.[20] Energy efficiency can significantly reduce this trend of increasing dependence, significantly improving Europe's energy security.

REALISING THE EFFICIENCY PIPELINE VIA "EFFICIENCY FIRST"

"Efficiency First" is an approach that involves a high-level commitment to systematically identify the multiple decision points where efficiency is overlooked or undervalued. Such an approach results in concrete policies and measures to ensure that investments happen wherever efficiency is more cost-effective or valuable than equivalent supply-side resources. It applies to various levels of decision-making – from the high-level framing of policy direction, to specific policies such as the rules gov-

14. In this paper, "pipes" and "wires" refer to investments in transmission and distribution infrastructure, including pipelines, electricity grids and substations.

15. Note that energy efficiency is considered in demand projections, but often these projections do not reflect EU energy efficiency policy goals. Moreover, energy efficiency is not proactively considered as a resource option for meeting energy services or infrastructure needs.

16. Neme, C., and Grevatt, J., (2015, January). *Energy Efficiency as a T&D Resource*. Northeast Energy Efficiency Partnerships. Retrieved from http://www.neep.org/file/2414/download?token=bNV2vVea. Neme, C. and Sedano, R. (2012). *US Experience with Efficiency as a Transmission and Distribution Resource*. Montpelier, VT: The Regulatory Assistance Project. Retrieved from www.raponline.org/document/download/id/4765.

17. Some US states quantify this as the "demand-reduction-induced price effect" (DRIPE), which is the reduction in gas commodity prices and capacity & storage costs attributable to a reduction in natural gas consumption. In Massachusetts, from 2009 to 2011, savings to gas consumers in Massachusetts from price suppression alone (not counting capacity savings) reached up to $1.9 million. See Hoffman, I., Zimring, M., and Schiller, S. (2013) *Assessing Natural Gas Energy Efficiency Programs in a Low-Price Environment*. Lawrence Berkeley National Laboratory. Retrieved from: http://emp.lbl.gov/sites/all/files/lbnl-6105e_0.pdf, p. 7.

18. It is worth noting that these benefits also translate to the power sector. For more on the system benefits of energy efficiency, see IEA, 2014, chapter 6.

19. It is important to note that the converse is true. In the US, the shale gas revolution has led to historically low gas prices, altering the relative benefit of energy efficiency programs over investments in natural gas infrastructure. See, for example, Avista. *2014 Natural Gas Integrated Resource Plan*. Retrieved from https://www.avistautilities.com/inside/resources/irp/gas/Pages/default.aspx. That said, Europe is not expected to have the volume of unconventional gas resource that the US has, and shale gas is assumed to come at a higher price.

20. European Commission, 2014b.

erning the internal energy market, and how decisions are made concerning resource adequacy and infrastructure investment.

Much of the international experience with Efficiency First comes from the United States, where there is a history of requiring regulated electricity and natural gas companies to identify the least-cost mix of resources to reliably meet electricity and natural gas demand. Beginning in the mid-1980s, many US states[21] adopted laws and regulations requiring power and gas utilities to follow "least cost" investment practices. In some of those states, major supply-side investments were tested against demand-side alternatives before permits for power plants or transmission lines could be issued or ratepayers charged for more expensive supply-side solutions. These policies saved consumers many billions of dollars in energy costs and reduced pollution.[22]

It is important to note that this least-cost planning approach was originally applied to vertically integrated electricity and natural gas companies – the regulated "utilities" – and referred to as "integrated resource planning" (IRP). Today, 15 US states have fully unbundled their electricity sectors, and a number of states have also unbundled their natural gas sectors to some extent.[23] As discussed further below, the concept of IRP has evolved over time, and states that have fully unbundled their electricity and natural gas sectors account for demand-side resources in different ways than those that have not. While it is important to recognize the differences between market structures, the lessons from the US provide an interesting example for how to integrate energy efficiency as a resource into the dynamically evolving energy sector in Europe.

THE EU REGULATORY FRAMEWORK

In order to understand how energy efficiency can be integrated into European energy regulation, policies and infrastructure planning, it is important to clearly identify where the opportunities for intervention lie. Traditionally, the European electricity and natural gas sectors were run by vertically-integrated monopoly companies. That is, the same company was responsible for generation, transmission, distribution, and retail supply of electricity and natural gas. Beginning in the 1990s, this changed with the first liberalisation directives for electricity and natural gas, which aimed to separate or "unbundle" the competitive aspects of energy supply with those that remain in the hands of monopoly companies. Over time, Europe has stepped up efforts to liberalise its electricity and natural gas sectors to drive greater competition of the generation and retail supply functions and increase cross-border integration.

Today, Europe is still establishing fully competitive generation and retail electricity and natural gas markets. A number of challenges remain, and work continues on designing markets and aligning regulation in a way that incentivises wholesale and retail competition in energy markets, while ensuring that the regulated transmission and distribution company incentives are also aligned with Europe's goals for competition, retail choice, and the transition to a low-carbon power system.[24] Moreover, there is growing recognition that more attention is needed on how to engage and empower customers in order to meet the fundamental goal of electricity and gas market reform: to secure a reliable system at lowest cost to consumers.[25]

Introducing Efficiency First principles into this process is an essential step in Europe's transition to a more competitive, affordable, low-carbon energy sector. The examples in this paper focus on the opportunities for introducing Efficiency First into regulation of Transmission System Operators (TSOs) and Distribution System Operators (DSOs). This recognises the fundamental role that transmission and distribution infrastructure play in energy security and diversity of supply in the natural gas sector, and the significant monetary savings that can flow from sizing additional infrastructure projects – including pipelines and liquefied natural gas (LNG) ports – in a way that first takes into account the potential to reduce demand through cost-effective energy efficiency.

Assessing the costs and benefits of energy efficiency

Before discussing how Efficiency First can be introduced into Europe's natural gas sector, it is worth pausing to discuss in more detail how the value of energy efficiency is determined. There is significant European and international experience in demonstrating the cost effectiveness of energy efficiency and other demand-side resources. There are also choices to be made in how the costs and benefits of energy efficiency are determined compared to supply-side resources.

Experience in Europe and elsewhere shows that a kWh of electricity or natural gas saved can be significantly cheaper than a kWh of electricity or natural gas generated. A recent analysis by Bloomberg of the cost of energy savings under energy efficiency obligation schemes in Europe and the United States found that in most cases the cost per "kWh" lifetime savings falls somewhere between 20 % and 35 % of the retail price of energy.[26]

Meeting the energy savings potential in Europe's existing buildings will require undertaking complex measures with varying costs and payback periods. As a result, it is necessary to look more deeply not only into where the least expensive measures lie, but at what combination of measures brings the

21. And some Canadian provinces, notably Ontario.

22. See the American Council for an Energy-Efficient Economy's *State Efficiency Scorecard* at http://aceee.org/sites/default/files/publications/researchreports/u1408.pdf and the Consortium for Energy Efficiency's State of the Energy Efficiency Program Industry at http://library.cee1.org/content/2013-state-efficiency-program-industry-report.

23. Unbundling here is used in the meaning of the Third Energy Package. In the US, the term "restructuring" is used to reflect the same basic idea – that is, the separation of the supply, transmission, distribution and retail functions of electricity and natural gas companies. A map of electricity sector restructuring in the US is available at US EIA. (2010). *Status of Electricity Restructuring by State*. Retrieved from http://www.eia.gov/electricity/policies/restructuring/restructure_elect.html, Details on natural gas restructuring are available at US EIA. (2010). *Natural Gas Residential Choice Programs*. Retrieved from http://www.eia.gov/oil_gas/natural_gas/restructure/restructure.html

24.See ACER. (2014). *Public Consultation on European Energy Regulation: A Bridge to 2025.* Retrieved from http://www.acer.europa.eu/Official_documents/Public_consultations/Pages/PC_2014_O_01.aspx and *Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2013.* Retrieved from http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER_Market_Monitoring_Report_2014.pdf.

25. European Commission. (2014c). *Consultation on the retail energy market.* Retrieved from http://ec.europa.eu/energy/en/consultations/consultation-retail-energy-market.

26. Rowlands-Rees, T. (2013). Energy efficiency obligation schemes: European overview, *Bloomberg New Energy Finance*, 20 September 2013.

greatest balance of costs and benefits to energy consumers, the energy system, and the economy as a whole.[27]

While a detailed analysis of cost-benefit methodologies is beyond the scope of this paper, it is worth noting several factors that can significantly affect the results of a cost-benefit analysis and therefore that will require further scrutiny under any energy efficiency programme:

COSTS

Three elements have a particularly influential effect on the level of costs associated with given efficiency measures: discount rates, payback times, and whose costs are included in the analysis.

Discount rates play an important role in determining the cost of efficiency measures and programmes. The discount rate is applied to determine the net present value (NPV) of energy savings that extend into the future. A higher discount rate will result in the value of future energy savings being considerably reduced, while a lower discount rate will indicate a greater valuation of future savings.

There is significant variation in the discount rates applied to energy efficiency in Europe and elsewhere. For instance, in the impact assessment to the Communication on Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy, the European Commission applied a discount rate of 17.5 % to energy efficiency measures in the household and transport sectors to determine the costs of meeting various levels of energy savings to 2030.[28] In evaluating the EU's current energy efficiency policy framework and estimating cost-effective energy savings potential to 2020 and 2030, Fraunhofer applied a range of discount rates which was significantly lower than that used by the Commission. For example, the rate used for the household and tertiary sectors for space heating and hot water ranged from 3.1 % to 5.4 %.[29] In the end, selecting the appropriate discount rate requires careful balancing of the factors that affect the NPV of an investment – such as the cost of capital, transaction costs and various risks and barriers — with the effect of targeted policies that help to reduce or overcome these factors.

Lifetime savings must be properly accounted for to ensure that longer-lived measures with higher upfront costs are not disadvantaged relative to short-lived, low-cost measures. The lifetime of energy savings measures can vary vastly from a few years for simple measures like low-flow showerheads to 30–40 years for deeper measures like building insulation.[30] The Energy Efficiency Directive requires Member States to take into account the lifetime savings when calculating energy savings under Article 7.[31] However, the European experience to date with energy savings targets under EEOs reflects different approaches to lifetime savings, indicating that fully accounting for lifetime savings in energy efficiency policies and programmes in Europe will require continued scrutiny.[32]

Who bears the costs is also an important consideration in cost-benefit analysis. In the US, where detailed cost-benefit methodologies have been developed over time, different cost-benefit tests account for the costs to different actors.[33] In general, the costs of energy efficiency programmes include, in some combination, those borne by the programme administrator, the costs of the energy efficiency measures borne by the participant and provided through financial incentives, non-energy costs, and (on occasion) lost revenues to the utility or energy company. The most comprehensive cost-benefit analyses account for all of these costs, save the lost revenues to the utility. The issue of lost revenues is addressed later in this paper. To get the broadest picture of the costs (and benefits) of an energy efficiency programme, it is important to include a comprehensive view of the costs, covering all the relevant parties.[34]

BENEFITS

Many energy efficiency programmes are clearly cost-effective based on an analysis of just a few of the main benefits, such as bill savings to participating end users or the energy resource cost savings to all customers and reduced need for investment in supply. At the same time, many other cost-effective opportunities are overlooked when only a narrow set of benefits is fully accounted for. This can create a bias in favour of supply-side resources by not providing an accurate comparison between the full costs of supply- versus demand-side resources.

Evidence shows that the multiple benefits of energy efficiency programmes can greatly exceed their costs.[35] The full range of benefits of energy efficiency can be broadly organised into four categories: benefits to the energy system; direct benefits to participating energy consumers; benefits that accrue to all customers; and benefits to society at large.[36] Increasingly, methods are being developed and evidence collected on how to account for the energy system, consumer and societal benefits of energy efficiency and other demand-side management (DSM) programmes. In addition to generating a more accurate understanding of the benefits of energy efficiency, quantifying

27. Neme et al, 2011.

28. European Commission, 2014b, p. 33.

29. Braungardt et al, 2014, p. 90.

30. Note that payback times spreading over several decades are not unique to energy efficiency investments. For example, the contract for differences established for the Hinkley Point nuclear reactor in the UK has been set for 35 years, and the ENTSO-G energy system wide cost-benefit methodology for projects of common interest is run on a wide range of cases in order to capture the uncertainty of the evolution of the gas market on a 21-year time horizon.

31. Energy Efficiency Directive, 2012/27/EU, Annex V.

32. Regulatory Assistance Project. (2012, June). *Best Practices in Designing and Implementing Energy Efficiency Obligation Schemes*. Report prepared for the International Energy Agency Demand Side Management Programme. Retrieved from http://www.raponline.org/document/download/id/5003.

33. National Action Plan for Energy Efficiency, *Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers*, November 2008. See also, California Standard Practice Manual, Economic Analysis of Demand-side Programs and Projects, October 2001. http://www.cpuc.ca.gov/nr/rdonlyres/004abf9d-027c-4be1-9ae1-ce56adf8dadc/0/cpuc_standard_practice_manual.pdf.

34. For more on the various tests applied to determine cost-effectiveness of energy efficiency programmes in the US, see: Woolf, T., Steinhurst, W., Malone, E., and Takahashi, K. (2012, November). *Energy Efficiency Cost-Effectiveness Screening*. Synapse Energy Economics and the Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/6149; National Action Plan for Energy Efficiency (2008). *Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policymakers*. Energy and Environmental Economics, Inc. and the Regulatory Assistance Project. Retrieved from http://www.epa.gov/cleanenergy/documents/suca/cost-effectiveness.pdf.

35. In fact, the non-energy benefits of energy efficiency programmes can exceed the quantified energy benefits. See International Energy Agency. (2014). *Capturing the Multiple Benefits of Energy Efficiency*. Retrieved from http://www.iea.org/Textbase/npsum/MultipleBenefits2014SUM.pdf. See also Lazar and Colburn, 2013.

36.See IEA, 2014, for an in-depth analysis of the multiple benefits of energy efficiency. See also Lazar and Colburn, 2013.

the broader benefits can help attract monetary, programme, and informational support from a broader set of stakeholders including energy companies, the public health sector, and low-income housing organisations.[37]

Introduction of Efficiency First will require a hard look at the methodology for cost effectiveness in Europe to ensure that costs and quantifiable benefits of efficiency are accounted for, including the non-energy benefits. This will require consideration of the full range of system benefits from energy efficiency investments (including avoided "wires and pipes" investments or investments in new generation), as well as accounting for potential free-rider effects, spill-over effects (that work to offset the impact of free-riders), as well as rebound effects.[38]

International experiences with Efficiency First

INTRODUCTION

Earlier, the development of "Efficiency First" in the US through IRP, and subsequently in unbundled gas and electricity markets, was described. Today, the approach of Efficiency First continues to apply in both vertically integrated markets and those that are partially or fully unbundled. This section explores four ways in which Efficiency First principles have been successfully incorporated into the natural gas and electricity sectors:

- IRP;
- Transmission and Distribution (T&D);
- The "all cost-effective energy efficiency" requirement; and
- Re-alignment of regulatory incentives.

INTEGRATED RESOURCE PLANNING

An IRP is a utility plan for meeting forecasted annual peak and energy demand, plus some established reserve margin, through a combination of supply- and demand-side resources over a specified future period. IRPs consider demand-side resources to varying extents. Those that most successfully address the benefits of demand-side resources undergo a thorough analysis to come up with the optimal resource portfolio.

While Europe no longer undertakes integrated planning, the experience from IRP is relevant in several ways. The long experience with Efficiency First in IRP demonstrates the feasibility of incorporating efficiency as energy sector resource alongside supply, as well as ways to balance efficiency potential with feasibility and cost-effectiveness. It provides examples of how this has been done across the whole supply chain – including the T&D sectors, which in Europe remain regulated.

Puget Sound Energy (PSE) provides a leading example of IRP in the US. PSE is a vertically integrated electricity and natural gas utility serving customers in Washington state.[39] Its resource plan goes beyond most by modelling energy efficiency as a resource that competes with supply-side resources in identifying the least-cost portfolio.[40] This is true for both the electricity and natural gas sections of the resource plan.[41]

PSE must file an IRP every two years with the Washington Utilities and Transportation Commission, the Regulator in the state of Washington. Washington law requires natural gas utilities to meet system demand with the "least cost mix of natural gas supply *and conservation,*" with conservation defined as any reduction in natural gas consumption resulting from increases in the efficiency of energy use or distribution. The IRP must, among other things, include "an assessment of commercially available conservation, including load management, as well as an assessment of currently employed and new policies and programs needed to obtain the conservation improvements."[42]

PSE considers demand-side resources through a multi-step process. It begins with determination of the technical potential, followed by analysis of which portion of that potential is "achievable." Achievable technical potential excludes resources not considered achievable based on customer response to past programmes implemented by PSE and other utilities. Remaining resources are grouped into cost bundles and compared to supply-side options to come up with the "economic" potential under various scenarios.[43]

In its 2013 IRP, the long-term cumulative achievable technical potential was found to amount to a 21 % reduction in forecasted retail sales by 2033 for natural gas, and a 16 % reduction by 2033 for electricity.[44] While the economic potential may be lower than this depending on market conditions, the IRP demonstrates that there is significant achievable energy savings potential in both the electricity and natural gas sectors. Over time, demand-side resources have resulted in significant energy savings for PSE and have the deferred need for acquisition of some supply-side resources.[45]

EFFICIENCY FIRST IN T&D

In the US and Canada there is growing experience with applying demand-side solutions as an alternative, or accompaniment, to investment in transmission and distribution infrastructure. Most of this experience arises from the electricity sector; however, there is some experience in the natural gas sector as well. This paper highlights examples from both sectors, as the lessons on the ability of demand-side investments to reduce, defer, or render unnecessary transmission and distribution upgrades will often apply to both. These lessons are particularly relevant to Europe, where regulation of the T&D sectors allows for greater oversight and direction on T&D investment.

37. Lazar and Colburn, 2013. Also, note success in the UK CERT programme with cooperation between obligated companies and social organisations.

38. IEA, 2014. See also Kenneth Gillingham, et al., *The Rebound Effect and Energy Efficiency Policy*. http://www.yale.edu/gillingham/ReboundEffectLongForm.pdf.

39. PSE does not own gas transmission pipelines, but rather purchases gas from the wholesale market.

40. For an analysis of IRPs in the western United States, see Hopper, N., et al. (2006). *Energy Efficiency in Western Utility Resource Plans: Impacts on Regional Resource Assessment and Support for WGA Policies*. Retrieved from http://emp.lbl.gov/sites/all/files/REPORT%20lbnl%20-%2058271.pdf.

41. PSE's most recent IRP (2013) is available at https://pse.com/aboutpse/EnergySupply/Pages/Resource-Planning.aspx.

42. Washington Administrative Code (WAC). No. 480-90-238. *Integrated resource planning.*

43. Puget Sound Energy. (2013). *Integrated Resource Plan. Chapter 6: Gas Analysis*, pp. 29–30. Retrieved from https://pse.com/aboutpse/EnergySupply/Pages/Resource-Planning.aspx.

44. Cadmus Group. (2013, May). *Comprehensive Assessment of Demand-Side Resource Potentials (2014–2033)*, pp. 2–3. Prepared for Puget Sound Energy. Retrieved from https://pse.com/aboutpse/EnergySupply/Documents/IRP_2013_AppN.pdf.

45. Puget Sound Energy, 2013, p. 38.

Reducing or shifting demand can dramatically decrease the burden on transmission and distribution systems. Energy efficiency and other DSM programmes can reduce overall energy consumption and peak loads, lower demand projections, reduce congestion, and cut associated T&D costs.[46] Some of the most effective energy efficiency programmes have focussed on stressed areas of the system in an approach referred to as "geo-targeting," as it involves geographically targeting demand-side programmes to address system needs. This section looks at geo-targeting in greater detail.

Experience with geo-targeting has demonstrated that well-designed, location-specific DSM programmes can significantly reduce the costs associated with T&D upgrades. One of the largest geo-targeting programs in New York is estimated to have saved customers more than $75 million between 2003 and 2010 when comparing the costs of the targeted energy efficiency programmes to the avoided T&D costs. This is the cost benefit without accounting for the other savings, including energy savings and system capacity savings.[47]

The programme was implemented by Con Edison, an electric and natural gas transmission and distribution company that supplies more than 3 million customers in the New York City area.[48] Due to the high population density of its service area and the high cost of upgrading underground infrastructure, Con Edison decided to assess the feasibility of implementing demand-side options to help defer the need for anticipated upgrades. The company contracted with energy service companies (ESCOs) to deliver load reductions in identified areas. The first phase of the project delivered 40 MW of peak load reduction, which was 7 MW less than contracted for. Con Edison collected significant damages from participating ESCOs for any non-performance. In subsequent years, delivered savings very nearly matched anticipated savings levels.[49]

The benefits of deferred T&D investments extended beyond cost savings. Deferring investment in T&D infrastructure allowed Con Edison to buy time for demand uncertainty to resolve, ultimately avoiding the installation of up to $85 million in capacity extensions that may never be needed.[50] Other experiences have similarly demonstrated the benefits of DSM programmes in helping to buy time to resolve uncertainty over the scope of anticipated T&D upgrades.[51]

Electricity companies in a number of jurisdictions have implemented DSM to help offset the costs of T&D investments. These include companies in New York, Vermont, California, and Oregon. These programmes support the notion that demand-side solutions can be valuable part of T&D planning. They can defer some T&D investments, save money for both energy companies and customers, and introduce added flexibility into T&D planning by allowing for incremental investment and changes in course as needed.[52] At the same time, it is important to consider lessons learned in programmes that have been less successful in deploying DSM as a resource, ensuring (among other things) that the proper lead times are in place to allow for planning and implementation, as well as learning and scaling over time.[53]

While demand-side resource programmes have been more recently introduced in the natural gas sector, there are some examples that such resources are being considered as an alternative – or complement – to supply. In addition to the examples provided in states with IRP, a recent decision by the Ontario Energy Board in Canada requires gas utilities to "provide evidence of how DSM has been considered as an alternative at the preliminary stage of project development" as part of all applications for leave to construct infrastructure projects. Applying DSM on a regional and local level complies with the Ontario government's policy of putting "conservation first" in electricity and gas infrastructure planning, where cost-effective.[54]

It is important to note that while there is less experience with demand-side resource investment as an alternative to natural gas T&D investment, there is significant experience with the ability of gas customer-funded programmes to deliver natural gas savings. Spending on customer-funded natural gas energy efficiency programmes in the US and Canada have increased steadily over the past several years. In 2012 expenditures in rose 16 % from the previous year to just over $1.2 billion, yielding incremental savings of nearly 425 million therms (12.45 billion kWh) of natural gas.[55]

ALL COST-EFFECTIVE ENERGY EFFICIENCY

A number of states in the US have a standard requiring that regulated energy companies, both those in vertically-integrated and partially of fully liberalised jurisdictions, achieve "all cost-effective energy efficiency." The following are several examples of how this standard is framed in different jurisdictions:

- In Connecticut, electric distribution companies are required, through a stakeholder process, to develop a comprehensive plan for the procurement of energy resources. Resource needs shall first be met through all available energy efficiency and demand reduction resources that are cost-effective, reliable, and feasible. The projected customer cost impact of any demand-side resources considered must be reviewed on an equitable basis with non demand-side resources.[56]
- California requires that all "load-serving entities"[57] procure all cost-effective energy efficiency measures. In addition,

46. Neme and Sedano, 2012. See also Kushler, M., York, D., and Vine, E. (2005). Energy-Efficiency Measures Alleviate T&D Constraints. *T&D World Magazine*. Retrieved from http://tdworld.com/distribution-management-systems/energy-efficiency-measures-alleviate-td-constraints.

47. Neme and Grevatt, 2015, p. 28.

48. New York is one of the states that has restructured both its electricity and natural gas systems, requiring utilities to separate transmission and distribution from generation and retail service. Con Edison is primarily a T&D company, which also provides retail service to customers who have not chosen an alternative supplier.

49. Neme and Grevatt, 2015, p. 28.

50. Neme and Grevatt, 2015.

51. Neme and Sedano, 2012.

52. Neme and Grevatt, 2015.

53. Neme and Sedano, 2012.

54. Ontario Energy Board. (2014, December). *Report of the Board, Demand Side Management Framework for Natural Gas Distributors (2015–2020)*, EB-2014-0134.

55. CEE, 2014.

56. Connecticut General Assembly. (2007, June 4). Public Act No. 07-242. *An Act Concerning Electricity and Energy Efficiency*, Section 51.

57. A load serving entity is any utility that supplies end-users, including aggregators. See CAISO. (n.d.). *Glossary of terms and acronyms*. Retrieved from http://www.caiso.com/Pages/glossary.aspx?&View={02340A1A-683C-4493-B284-8B949002D449}&FilterField1=Letter&FilterValue1=L.

California utilities must undertake procurement plans that incorporate energy efficiency and meet concrete targets.[58]

- Massachusetts law requires that the Department of Public Utilities (the regulator) ensure that "electric and natural gas resource needs … first be met through all available energy efficiency and demand reduction resources that are cost-effective or less expensive than supply."[59]

In order to better understand how this type of standard can be implemented in practice, this section looks in more detail at the Massachusetts "all cost-effective" requirement. Massachusetts has consistently ranked among the top states for energy efficiency in the US, thanks to an ambitious combination of legislative policy and regulatory oversight.[60]

To meet the "all cost-effective" requirement, electric and natural gas distribution companies, and municipal aggregators with certified efficiency plans,[61] must jointly prepare an electric energy efficiency investment plan every three years.[62] Each plan must provide for the "acquisition of all available energy efficiency and demand reduction resources that are cost-effective or less expensive than supply …" The plans are developed through a formalised stakeholder process and are submitted to the regulator for approval.

The plans must detail a broad range of costs and benefits of demand-side resources, as well as implementation details. This includes an assessment of the estimated lifetime cost, reliability and magnitude of all available energy efficiency and demand reduction resources that are cost-effective or less expensive than supply. Plans must further include the amount of demand-side resources proposed to be acquired, along with a description of the proposed programmes. The plans must also estimate benefits, including reductions in capacity and energy costs, increases in rate stability and affordability for low-income customers, the estimated reduction in peak load, and any estimated economic benefits such as job retention and growth or economic development. Lastly, the plans include a budget, proposed performance incentives, and a fully reconciling funding mechanism.[63] The latest plans have incrementally increased annual savings to 2.6 % of retail electricity sales, and 1.14 % of retail natural gas sales, in 2015.[64]

Today, seven US states have in place an all cost-effective requirement, which is used to set concrete annual energy savings targets for energy companies. The average (and median) target level for annual end-use energy savings in these states is substantially higher than that in the remaining 18 states that have in place an energy efficiency obligation.[65] This is a particularly interesting observation as Europe moves to implement Article 7 of the Energy Efficiency Directive and considers amendments for the 2030 timeframe. The current cumulative annual target of a 1.5 % reduction in annual sales – which, as a result of exemptions, comes closer to 0.75 % – could be strengthened through an Efficiency First approach to set a target based on all cost-effective energy efficiency potential.

REGULATORY INCENTIVE STRUCTURES

Under traditional ratemaking – in the US and Europe alike – demand-side solutions can cause regulated energy companies to lose money. This is because of the way that regulators establish energy company revenues. Often, a regulated company's revenues are based on a "cost-plus" model, which involves calculating the amount of money needed to cover a utility's costs of service for a given time period, plus a reasonable rate of return on investment. This amount is then divided by expected sales to come up with regulated tariffs. Regulated companies meet their revenue requirement if their sales volumes equal projected levels. They gain additional revenues in the case of increased sales, and lose revenues if sales decline. This creates a "volume driver" for revenues, which translates into a disincentive for demand-side programmes as they result in decreased sales and therefore lost revenues.

In the US, 22 states have removed the volume driver (referred to in the US as "decoupling"[66]) for natural gas, and 13 have done so for electricity.[67] The European Energy Efficiency Directive requires Member States to introduce a similar policy for TSOs and DSOs in the electricity sector, though no equivalent standard yet exists for natural gas.[68] Application of Article 15.4 of the Energy Efficiency Directive is discussed in more detail in the next section.

In addition to addressing the disincentive for energy efficiency to contribute to energy savings, a number of states have also introduced incentives to help motivate energy companies to invest in or support DSM programmes. This includes programme cost recovery, which while not a positive incentive, ensures that utilities recover the costs incurred in administering energy efficiency programmes. In the EU, programme cost recovery is available to obligated energy companies under several EEOs.

Performance incentives go further and actually provide positive incentives for meeting specified targets, often accompanied by penalties for non-compliance. The money for the incentives can come in the form of "shared savings," where the energy

58. California Legislature. (2006). Assembly Bill No. 2021. *An act to add Section 25310 to the Public Resources Code, and to amend Section 9615 of the Public Utilities Code, relating to energy efficiency.*

59. 198th General Court of the Commonwealth of Massachusetts. (2008). Session Law: Chapter 169 of the Acts of 2008. *An Act Relative to Green Communities*, Section 21.

60. Based on ACEEE's Efficiency Scorecards (http://aceee.org/state-policy/scorecard).

61. The Massachusetts restructuring (i.e. liberalisation) law, allows local municipal or county governments to aggregate the electric loads of the consumers within their boundaries in order to negotiate more favorable terms with a power supplier. See Massachusetts General Laws, Chapter 164, § 134 (a), (b). It is interesting to note that municipal aggregators have the option to access money collected through a statewide "system benefits charge" on electric bills to support DSM programmes if they prepare an energy plan. See Massachusetts Department of Energy Resources. *Guide to Municipal Electric Aggregation in Massachusetts*. Retrieved from http://www.mass.gov/eea/docs/doer/electric-deregulation/agg-guid.pdf.

62. While Massachusetts has restructured its electricity and natural gas sectors, retail competition remains limited and most customers continue to receive retail service from a default supplier (e.g., the regulated distribution companies).

63. Massachusetts Session Laws, Chapter 169 of the Acts of 2008, Section 21.2.

64. ACEEE. (2014). *State and Local Policy Database: Massachusetts*. Retrieved from http://database.aceee.org/state/massachusetts.

65. Gilleo, A. (2014). *Picking All the Fruit: All Cost-Effective Energy Efficiency Mandates*. Retrieved from http://aceee.org/files/proceedings/2014/data/papers/8-377.pdf.

66. For more on decoupling, see Regulatory Assistance Project. (2011). *Revenue Regulation and Decoupling: a Guide to Theory and Application*. Retrieved from http://www.raponline.org/docs/RAP_RevenueRegulationandDecoupling_2011_04.pdf.

67. As of August 2013. At the time, three states had pending decoupling policies for electricity and natural gas. See National Resources Defense Council (NRDC). *Gas and Electric Decoupling* [Web page]. Retrieved from http://www.nrdc.org/energy/decoupling/.

68. Energy Efficiency Directive, 2012, Article 15, paragraph 4.

company "shares" some of the savings that consumers see as a result of efficiency programmes. In some jurisdictions, energy companies may also enjoy an increased rate of return on certain investments to help drive the use of demand-side resources.[69]

Applying Efficiency First in Europe

While the natural gas sector is structured differently in the US and Europe, incorporating Efficiency First into European energy regulation, policies, and infrastructure planning is possible and has the potential to yield significant benefits to the energy system and to consumers. In Europe, work is underway on the EU's climate and energy goals to 2030, as well as on a number of specific instruments that are expected to deliver these goals. This includes the ETS, Energy Efficiency, Energy Performance of Buildings, Ecodesign, and Renewables Directives, as well as legislation relating to energy market liberalisation under the Third Energy Package. As work continues in these areas over the next couple of years, it will be important to both set a coherent high-level framework and to improve on the implementing legislation in a way that ensures delivery of the least-cost portfolio of resources that can meet Europe's goals for energy security, competitiveness and sustainability.Demand-side resources should play a central role in this process if Europe is to take full advantage of its domestic resources.

This section looks at ways in which Efficiency First principles can be applied to strengthen Europe's climate and energy framework. Specifically, it examines two ways in which Efficiency First could be incorporated into natural gas regulation, policies, and infrastructure planning:[70]

- Regulation of DSOs and TSOs.
- Cross-border planning and investment packages.

REGULATION OF DSOS AND TSOS

The Internal Gas Market Directive focuses extensively on the role of DSOs and TSOs in the internal gas market. While much of the focus is on unbundling of the gas sector, the Directive also establishes the roles and responsibilities of DSOs and TSOs and provides direction on tariff setting and long-term planning. Efficiency First could be introduced at several points within this framework.

Firstly, the Directive already includes the possibility for Member States to introduce a public service obligation (PSO) on natural gas undertakings relating to, among other things, energy efficiency.[71] Such a public service obligation could come in the form of a least-cost investment requirement that calls on consideration of supply- and demand- side resources anytime an undertaking considers an expansion of existing infrastructure. An undertaking is defined as "a natural or legal person carrying out at least one of the following functions: production, transmission, distribution, supply, purchase or storage of natural gas, including LNG, which is responsible for the commercial, technical and/or maintenance tasks related to those functions."[72] It would be important to consider whether a PSO would best apply to just the regulated T&D companies, or whether it might also extend to the competitive portions of the natural gas sector.

Introducing a least-cost investment requirement would be consistent with the stated goals or "tasks" of TSOs and DSOs. Currently, the Directive states that each TSO and DSO shall: "operate, maintain and develop under economic conditions secure, reliable and efficient" system with "due regard to the environment" and – for DSOs – due regard to energy efficiency.[73] Introducing a least-cost investment requirement could, in fact, improve the economics, reliability and efficiency of the overall system by coming up with the most cost-effective portfolio of resources through a cost-benefit analysis.

Calling on regulated T&D companies to invest in demand-side resources as part of their overall resource portfolio requires careful consideration of their business models. It is important to remove the traditional volume driver in order to remove the signal that a reduction in sales (through demand-side measures) will result in a loss of revenues, and therefore is bad for the company. This can be achieved through, for example, a revenue cap, combined with a productivity factor (RPI-X).[74] An additional step is to introduce incentives for T&D companies to invest in demand-side resources, for example by allowing the companies to share in some of the benefits flowing from DSM programmes or by setting specific performance metrics associated with rewards and penalties for achievement or non-achievement.[75] As mentioned earlier in this paper, Article 15.4 of the Energy Efficiency Directive already calls on Member States to remove the incentives that are detrimental to the overall efficiency (including energy efficiency) of the electricity system, and to ensure that network operators are incentivised to improve efficiency in infrastructure design and operation. This provision does not yet extend to the natural gas sector.

It is worth noting that introduction of Efficiency First principles for TSOs and DSOs is also in line with the general objectives of the regulatory authorities as set out in the Natural Gas Directive. Article 40 (d) lists, among other competences of the NRAs, "helping to achieve, in the most cost-effective way, the development of secure, reliable and efficient non-discriminatory systems that are consumer oriented, and promoting system adequacy, an, in line with general energy policy objectives, energy efficiency …"[76]

69. For more on energy company incentives for energy efficiency, see EPA's National Action Plan for Energy Efficiency and Enernoc. (2009). *Utility Incentives for Demand Response and Energy Efficiency*. Retrieved from http://www.enernoc.com/our-resources/white-papers/utility-incentives-for-demand-response-and-energy-efficiency.

70. It is worth noting that there will be many parallels between the opportunities for Efficiency First in the natural gas and electricity sectors. There are also several other places where Efficiency First might be incorporated into the energy sector, including through increasing ambition of energy efficiency obligations on energy distribution or retail companies, as discussed earlier in the paper.

71. Directive 2009/73/EC, Article 3.2.

72. Directive 2009/73/EC, Article 2.1.

73. Directive 2009/73/EC, Articles 13.1 and 25.1.

74. Lazar., J. (2014, May). *Performance-Based Regulation for EU Distribution System Operators*. Montpelier, VT: The Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/7332.

75. Lazar, 2014.

76. European Council. (2009). Directive 2009/73/EC: Concerning common rules for the internal market in natural gas, Article 40(d). Retrieved from http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0073.

CROSS-BORDER PLANNING AND INVESTMENT PACKAGES

As part of Europe's pursuit of an integrated, secure, reliable and sustainable energy sector, Europe has established guidelines for trans-European energy networks (TEN-E).[77] These guidelines aim to help Europe identify priority, cross-border projects that benefit from expedited permit granting procedures and improved regulatory treatment. In October 2013, the Commission adopted a list of these projects, designated "projects of common interest" or PCIs. Neither the TEN-E guidelines nor the PCIs selected explicitly mention energy efficiency as a consideration, outside peripheral consideration in projects relating to bi-directional metering and communication. In addition to facilitated procedures, the PCIs have access to European funding, including from the almost €6 billion available through the Connecting Europe Facility up to 2020.[78]

Implementation of Efficiency First under the TEN-E guidelines could again, take the form of a requirement that, in considering PCIs, cost-effective demand-side resources should be considered alongside supply-side resources in meeting cross-border needs. The guidelines currently call on ENTSO-E and G to publish their methodologies for a harmonised energy system-wide cost-benefit analysis for PCIs; however, these methodologies are not required to – and do not – take into account demand-side resources alongside supply in determining investment needs.

This would be consistent with the TEN-E objectives of supporting completion of the internal energy market "while encouraging the rational production, transportation, distribution and use of energy resources….and to contribute to sustainable development and protection of the environment."[79] The guidelines further recognise that "energy efficiency gains may contribute to reducing the need for construction of new infrastructures" and the continued drive to decarbonise the energy system.[80]

Similarly, national and EU-wide TYNDPs, required under the natural gas directive and regulation should take into account the opportunities for demand-side resources to address system needs. In fact, long-term planning has proven to be one of the most valuable tools in system planning in jurisdictions in the US that consider demand-side resources in transmission and distribution planning.[81]

Conclusion

As Europe considers how to address energy security in the wake of the Ukraine crisis, and to strengthen its climate and energy policy looking forward to 2030 and 2050, energy efficiency in buildings has a central role to play. In fact, energy efficiency and other demand-side resources are central to meeting Europe's triple objectives of ensuring a secure, competitive, sustainable energy system. And the potential is significant. Buildings in Europe alone account for about 40 % of all energy consumption, as well as 40 % of gross inland consumption of natural gas and 61 % of imported gas. Various studies have assessed the potentials of energy savings in existing buildings, and the results identify significant untapped savings. A recent analysis by Ecofys finds that deep building renovations could reduce gas consumption in the building sector by 95 % by 2050 from today's levels, significantly reducing European reliance on imports.

Yet in order to tap into this potential, policies and measures are needed to overcome barriers to cost-effective energy efficiency. While Europe currently has a number of policies supporting energy efficiency in existing buildings – including the Energy Performance of Buildings, Ecodesign, and Energy Efficiency Directives – these policies need to be strengthened and further supported by complementary mechanisms. Fundamentally, it is essential to begin to consider buildings as an energy resource that should be weighed against supply-side resources in making policy and investment decisions. Treating buildings as a dynamic part of the energy system requires a deep look at the policies and regulations underlying Europe's energy system. It will not happen overnight. However, by introducing "Efficiency First" principles into natural gas infrastructure planning and regulations, Europe can begin to construct an efficiency pipeline that will help meet its energy policy and security objectives at least cost.

77. European Union. (2013). Regulation No. 347/2013: Guidelines for trans-European energy infrastructure. Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1425398739322&uri=URISERV:180202_1.

78. Ibid.

79. Ibid., paragraph 5.

80. Ibid., paragraph 7.

81. Neme, 2015.